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A CONTRIBUTION TO THE QUESTION OF METASTASIS OF CARCINOMA IN THE OVARIES AND DOUGLAS'S CUL-DE-SAC[1]

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THE judgment on the preponderance of the primary or secondary nature of carcinomata of the ovaries and the explanation of their subsequent genesis through primary carcinomata of remote organs in the abdominal cavity, has undergone a great change in the last decade. Even less than ten years ago an observation of a secondary ovarian carcinoma was considered a rarity, and mentioned as such in the text-books of that period.

The publications laying the foundation for the correction of this error, appeared at about this time, preceded, however, by some isolated observations foreshadowing the coming of the radical change.

Bucher (1), who probably was the first to accept a carcinomatous implantation through the intact epithelium of the ovary, asserted that the bilateral carcinomata of the ovaries are always secondary ones, and explained their origin as depending in most cases upon the carcinomata of the stomach found often at the same time. Heinrichs (2) and Rathert (3) both warn against incomplete operations in cases of carcinoma of the ovaries where the existence of a primary tumor in the abdominal cavity has not been recognized.

To Kraus (4) and Schlagenhaufer (5) however belongs the merit to have approached this question with perfect understanding, and to have cleared it in relation to the secondary character of the carcinomata of the ovaries. It is true that Kraus' work occupies itself with the explanation of the process of metastasis, a task which he tries to solve by microscopical and experimental investigations, to the consideration of which we shall return later. Schlagenhaufer (5) collected a series of seventy-nine cases from literature including eight observations of his own, which prove without doubt the relatively frequent secondary affection of the ovaries in cases of malignant tumors of other organs in the abdomen. Schlagen-

Fig. 1. Pouch of the Douglas excavation from case 11 (primary colloidal carcinoma of the head of the pancreas). Hæmalaun-eosin, low power. In the lymphatic vessels of the serosa, and only in its superficial layer masses of carcinomatous cells (h); the endothelium of the serosa is protruding in places (e); the deeper layer of the serosa (t) and the loosely fibered subserosa (sb) is perfectly free from carcinomatous cells.

Fig. 2. Place from the same part under high power. Particles of carcinoma (br) are lying free upon the surface of the serosa (s), only fixed with a process to the latter.

Fig. 3. Horizontal section through Douglas and wall of the rectum from the same case. Hæmalaun-eosin, total view. s, Serosa of the Douglas in the innermost (superficial) layer. sb, Loosely fibered subserosa. m, Longitudinal muscular fibers of the wall of the rectum. m', Annular muscular fibers of the wall of the rectum. sm, Submucosa of the rectum. mu, Mucosa of the rectum.

[1] From the Pathological-Anatomical Institute of the Friedrichshain Hospital, Berlin, Professor Dr. L. Pick, Prosector.

haufer correctly states that this considerable number certainly represents only a fraction of the really observed but not recognized cases.

Although this view met at first with a good deal of opposition it was soon followed by Glockner's (6) fine work on secondary carcinoma of the ovaries, and a few years later, at the Gynæcological Congress in Kiel, 1905, by the report on ovarian carcinomata by the two principal speakers, Pfannenstiel and Hofmeier, who confirmed these views in every sense.

The reports of cases belonging to this class have constantly increased since that time, and although a few gynæcologists like Schmidt and Klein in the discussion following T. A. Amann's (7) paper declined to accept this view, it has nevertheless gradually met with general recognition.

Stickel (8) added a series of fourteen new observations from the Pathological Institute in Greifswald. Schauta (9) reports similar cases, and Sternberg (10) remarks in a communication of his own cases that the primary tumors in the stomach may be so small that they escape clinical recognition by the absence of symptoms, and may even be overlooked at the autopsy.

In the French and English literature not so much has been published about this theme. In the report of his observations Gouilloud (11) speaks of the metastatic character of many carcinomata of the ovary previously considered as primary, and Bland-Sutton (12) by reason of his observations believes to be obliged to advocate a revision of the views on the nature of carcinomata of the ovaries. We could considerably increase the already quoted number of cases belonging to this class from the publications of the last few years, but the aim of this work lies more in the direction of arriving closer at the manner of the formation of the metastasis, a question which will form the leading idea of the following part.

The different views regarding the manner of the origin of the metastasis from distant, i. e., higher situated organs of the abdominal cavity to the ovaries are more decidedly opposed to each other. They are:

a. Through the blood circulation in arterial and venous retrograde direction.

b. Through the retrograde lymphatic current.

c. By graft implantation.

A road of the metastasis through the blood passages, either with the arterial or by the retrograde venous current with preference of the germinative gland seems to me to be entirely excluded on the ground that such carcinomatous metastasis never befalls the testicle, a fact which cannot be united with this theory. Schmorl (13) pleaded for the road by the retrograde lymph current in the Dresden Gynæcological Society at the occasion of Weindler's exhibit of ovarian tumors. He asserts that the bilateral carcinomata of the ovaries are frequently of a metastatic nature. Frequently one finds after a systematic microscopical search metastatic carcinomata, not only in cases of primary carcinoma of the stomach but also with carcinomata of the mamma, with carcinomata of the lungs and bronchial tubes, of the oral cavity, and of the œsophagus.

They do not cause any very noticeable clinical symptoms. The metastatic growths are frequently located in the deeper parts of the ovaries so that they escape at first a superficial examination. Frequently they are also so small that they can only be found by an exact microscopical search. This explanation of the metastasis belonging to this class is also favored by Glockner (l. c.) and Pfannenstiel (14). They believe in a transportation by the retrograde lymph current and Sternberg contradicts the view defended in the discussion by Schauta and Kraus (9) that metastasis by graft to the deepest situated parts of the pelvis cause these ovarian growths. Here Kraus (4) obtained again a different opinion from a study of the material from v. Recklinghausen's Institute, and by animal experiments. He examined microscopically five cases of carcinoma of the ovaries in which existed at the same time carcinomatous growths of other organs of the abdominal cavity (stomach, intestines, and liver) and he proved the metastatic nature of the ovarian carcinomata. At the same time the microscopical finds in his series of macroscopically nearly totally unchanged ovaries caused him to accept an implantation metastasis from the ovarian surface. The germi-

native epithelium was nearly exclusively affected, only in a few places invading masses of carcinomatous tissue from the surface led to more centrally located metastatic growths of the ovary.

Kraus undertook some experiments on animals in order to lend support to his views. With a Pravaz syringe he injected a very fine emulsion of China ink in warm physiological saline solution, through a small wound into the abdominal cavity of rabbits and sewed up the wound. He then examined the ovaries at different times after the injection. He found many particles of China ink embedded in the leucocytes but only a few free ones in the stroma of the ovaries and concluded from these findings a certain permeability of the superficial strata of the ovaries for the passage of corpuscular elements. As the result of his investigations, which were also founded on animal experiments, Wolfheim (15) opposed this explanation. He repeated the experiments of Kraus following his methods, but only deposits of particles of the China ink on the surface of the ovaries were found, never an entrance, or still less a penetration through the intact germinative epithelium. As the result of his examinations, he sums up:

1. That the intact germinative epithelium of the ovary offers secure protection against the advance of corpuscular elements from the abdominal cavity.

2. That the slight physiological injury even of the epithelial covering of the ovary as it occurs in every ovulation, renders their immigration possible.

3. That according to his own investigations Kraus' experiments cannot be accepted as free from objection, and all the conclusions which have been drawn from them are invalid.

Polano (16) has recently communicated the results of his examinations which lend a confirmation to the views of Kraus. He has injected emulsions of China ink in physiological salt solution into the abdominal cavity of rabbits and has observed immigration into the inner part of the ovary through the intact germinative epithelium. In these experiments it proved immaterial whether the emulsions were injected filtrated, or unfiltered, or whether German or China ink had been used. The particles of China ink travel mostly free, not embedded in leucocytes, through the germinative cells into the adjoining connective tissue. He could observe the same phenomena in sexually mature human ovaries which, directly after their extirpation, were brought at body temperature still into the emulsion.

It is true that the immigration into the epithelium of the general peritoneum is much more ample so that a certain resistance of the ovarian surface-epithelium must be accepted.

In order to meet any doubts of the immigration of the China ink particles as to the possibility of their artificial transportation and secondary amalgamation, Polano tried also the introduction of bacteria into the abdominal cavity. He believed this to correspond better with the biological conditions of the cancer metastasis by living cellular organisms. His introductions of hay bacilli into the abdominal cavity of rabbits furnished the same results as the experiments with emulsions of China ink. The hay bacilli were observed in the interior of the ovaries, their immigration had been made through the germinative epithelium.[1]

Sitzenfrey (17) describes a very instructive case with relation to this question. Wölfler had performed a gastro-enterostomy on a woman 35 years old for an inoperable carcinoma of the stomach. Three months later the woman died. The autopsy showed a carcinoma of the pylorus, which had penetrated into the muscularis but had not yet reached the serosa. There were carcinomatous metastatic foci in the retroperitoneal, lumbar, periportal, and supraclavicular lymphatic glands, also in the omentum, pancreas, and pericardium. The woman was six months pregnant. There were a few metastatic nodules upon the serosa of the uterus, a good many upon the Douglas serosa. The ovaries looked macroscopically normal, to one place of the right ovary only a small fringe of omentum, the size of a kernel of flaxseed, adhered, which proved upon microscopical examination to be impregnated with carcinomatous foci. The left ovary was entirely free. On microscopical examination both ovaries showed the presence of extremely

[1] The experiments with hay bacilli were published in the report of the Centralb. f. Gynækologie, 1907, p. 784. On comparison with the orginal paper in the proceedings of the Ges. f. Gynækologie, I did not find them mentioned there.

small metastatic carcinomatous foci, located on the surface. Isolated carcinomatous cells were found implanted between the cells of the germinative epithelium. In some places Sitzenfrey observed small foci in the most exterior layers of the cortex stroma, which emanated from those of the germinated epithelium, and he believes that the restriction of this invasion to the surface must be ascribed to the resistance of the albuginea and the stroma of the cortex. The stroma and the medullary parts with the exception only of the most exterior part of the former which joins the albuginea, were entirely free of carcinomatous masses. He feels justified to state that the carcinomatous cells could only have reached the surface of the ovaries by way of implantation. Considering the operative results obtained by him and Schenk (18) he arrives by a logical course at recommending the extirpation of the normal ovaries, a recommendation however, which he also deems valid for metastatic infections through the lymphatic vessels.

Closely connected with the theory of metastasis by implantation is the question about the character of the local conditions of the carcinoma which cause the implantation upon the ovaries from remote organs in the abdominal cavity, a question the decision of which has also a great practical importance.

Glockner (l. c.) writes that the kind of metastasis formation (implantation) described by Kraus does not fit in for those carcinomata of the abdominal organs which have not reached the serosa; in such cases the road must be a different one. Even the latest edition of the classic monograph of Pfannenstiel (l. c.) shares this view.

Kraus on the other hand defended his opinion in the already quoted discussion (9) and in a successive addition that: "It is untirely unnecessary that there should be, in cases of carcinoma of the stomach, where a dissemination of carcinomatous cells into the abdominal cavity has occurred, a macroscopically perceptible penetration of the carcinoma through the serosa. It is probably sufficient that isolated tracts of carcinomatous tissue, even if visible only microscopically should grow through the lymph or tissue clefts until they reach the serosa, where a liberation and rubbing off of carcinomatous cells through the peristaltic action of the intestines is brought on. In such cases we may also speak of a perforation of the carcinoma into the peritoneal cavity, though it is impossible to demonstrate it macroscopically in the anatomical specimens."

Kraus' cases hardly furnish a firm basis for this part of his theory. The history of his case (No. 3) which is introduced as its proof, shows that the ulcerated carcinoma of the mucosa of the stomach has penetrated through the serosa and shows numerous metastatic growths of the peritoneum. It is possible that they were brought from the ulcerated surface by way of the lymphatic vessels, and then led directly to implantation on the ovaries.

This is the present state of the Kraus-Polano-Sitzenfrey view of the theory of implantation. All the above mentioned investigations had been undertaken to demonstrate the secondary nature of certain carcinomata of the ovaries. They had been so far successful for the earliest stages of the involvement when macroscopical changes of the ovaries could hardly or not at all be seen. The exclusive lesion in the primary stages of the most superficial tissue strata in the ovaries, the absence of pathological anatomical changes in other organs with the exception of the peritoneum, together with the experimentally proven permeability of the ovarian germinative epithelium for corpuscular elements had led to the adoption of a metastasis by implantation in the ovaries. For its explanation it was argued that following the laws of gravity, and moved on by peristalsis and lymph current the particles of carcinomatous tissue travel downwards, and are retained in their wanderings by the deeply situated ovary. With reference to the general peritoneal space this view had already been expressed by Virchow (19) with the words: "If for example there exists originally a carcinoma of the stomach which has involved the serosa one sees not infrequently a multiple eruption of the carcinoma on the peritoneum, but not equally distributed, but often on points quite remote from each other, and just in such places which are apt to catch objects that are gliding down over the smooth peritoneal surfaces of the abdomen,

for instance, in the location of the ligamenta vesicæ lateralia, in the excavatio recto vesicalis, recto uterina, or utero vesicalis. In these places new small tumor isles, daughter nodules, are formed just as if a seminium had been thrown out which had fallen here and there, and had germinated. I cannot compare this phenomenon to anything better than to the occasional appearance of a tree or a shrub on a mountain side, the presence of which can only be explained through their having been planted there in a certain way by seeds, and that possibly in their fall isolated seed grains had been caught on each projection and had taken root there."

This effect of gravity in metastatic infection of the peritoneum, which is so extremely important for the proof of the theory of implantation, we find entirely neglected in the writings on this question. Whilst the ovaries are made objects of the most careful examination, the simultaneous macroscopical state of the deepest parts of the peritoneum is only briefly mentioned, and nothing is found about its microscopical inspection. And just the deepest part of the peritoneum, the cavum Douglasii, should figure as the most important battle ground for the decision of the question of implantation.

If in the selection of cancer metastasis a preference of the Douglas pouch over other higher situated parts of the peritoneum could be established, nay, if going further a difference could possibly be shown between various parts of the Douglas itself, located as they are at different levels, then a final proof for the theory of implantation were furnished, not only for the peritoneum, but also for the deep lying ovaries and for the general question of metastasis by implantation. If cases might be found in which the Douglas and the Douglas only were affected possibly in its most superficial layer alone, then infection by the retrograde blood and lymph current would be excluded and implantation through the effect of gravitation would be finally established for such cases. This supposition being correct, the first permanent stations for the vagrant carcinoma particles, corresponding to the effect of gravity, should be found in the Douglas, and here the earliest changes should be met. Thus one could expect that eventually an early stage would be encountered which showed distinct microscopical but no macroscopical carcinomatous lesions.

It is easily understood that it is quite indifferent for the decision of this question if the cadaver of males or females who died of carcinoma served for examination. It was necessary however, to examine the roads which had to be considered in the transportation of the carcinomatous seminium, in other words, the lymph passages between primary tumor and Douglas. The primary tumor also in its relation to the peritoneal cavity demanded our attention, especially with regard to the question of the free passage of the carcinomatous particles through the intact serosa. The conditions for the solution of our problem were accordingly the following:

1. Exclusion of the retrograde lymph transportation.
2. Separate examination of the lower and higher situated parts of the Douglas.
3. Examination of the ovaries in cases of carcinomas of females, to learn the chronological relation between implantation of the ovary and that of the Douglas.
4. The exact relation of the carcinoma to the surface of the serosa.

Following these lines I have upon the proposition of Prof. Dr. L. Pick, studied these questions of the metastasis of carcinoma on the large material of his institution. Prof. Pick exhibited also a most appreciable interest in my work by the continued control of my microscopical specimens.

I have examined altogether fifteen cases without choice of sex. They were taken in regular order as such cadavers came in that showed carcinomata, and twice sarcomata of the organs of the upper part of the abdominal cavity (twice also of the thoracic cavity) and where macroscopically changes of the lower abdominal organs could not be discovered. This last rule had its exception in isolated specially mentioned cases in which smallest miliary deposits were found in the Douglas, and an examination was carried through to determine their macroscopically dubious nature.

The course of the examination was the following: I took in each case material of the primary tumor, regional lymph glands from

the upper part of the abdominal cavity (of the cardia, small and large curvature), mesenteric, and retroperitoneal (aorta) lymph glands, and the entire Douglas with the underlying fat and connective tissue, eventually also with the anterior wall of the rectum about five centimeters wide, exceeding the deepest place, the concavity of the pouch by about 2–2.5 cm. anteriorly and posteriorly. In females the ovaries also were examined. The pieces were hardened in 10 per cent formaline, and then were passed through the alcohol series to xylol as preparation for the embedding in paraffin. The sections were stained with hæmalaun-eosin and after von Gieson. The Douglas was divided transversely into three parts (the bottom of the pouch and its anterior and posterior continuation). The different pieces were spread carefully on filter paper and examined separately, after having undergone the identical treatment as the pieces of the organs.

For the sake of brevity the autopsy reports of those cases where the examination showed no particular change in the Douglas are rendered in extract only and the microscopical findings given in a cursory way.

CASE 1. Autopsy No. 1690–1909. Pretty large, poorly nourished male cadaver; 42 years old.

Stab wound on the neck and in the third and fourth left intercostal spaces. Blood in the pericardium, small stab wound in the wall of the left ventricle. Brown atrophy of the heart. Slight arteriosclerosis of the aortic valves and of the aorta. Pneumothorax of the left side with some bloody fluid in it. Emphysema of the lungs. Adhesions of the lungs with the pericardium, adhesions of both pleuræ. Purulent bronchitis on the right side. Catarrhalic bronchitis on the left. Chronic interstitial nephritis with parenchymatous degeneration. Large ulcerated carcinoma of the pylorus, and of the first part of the duodenum. Dilatation of the stomach; atrophy of the mucosa with fresh hæmorrhages. Strong adhesions around the stomach, and swelling of the lympathic glands of the mesentery and of those around the aorta. Adhesions around the gall-bladder, swelling of the lympathic glands in the hepatoduodenal ligament. Moderate fatty infiltration in the liver. The lymphatic glands at the head of the pancreas are enlarged.

Microscopically:

Pyloric tumor: adenocarcinoma.
Lymphatic glands: free.
Douglas: free.

CASE 2. Autopsy No. 1093–1909. Moderately large male cadaver, dark icteric color; 61 years old.

Hypertrophy of the left ventricle. Parenchmatous degeneration of the heart. Arteriosclerosis of the mitral and aortic valves. Slight hydropericardium adhesions of pleuræ on both sides. Hydrothorax on the right side. Slight slaty induration of the apex of the left lung. Fibrous scars of the apex of the right lung. Purulent bronchitis. Slight hypertrophy of the spleen. Acute parenchymatous nephritis. Kidney cyst on the right side. Ulcus rotundum ventriculi. Stenosis of the hepatic duct by a small carcinomatous tumor, situated at the bifurcation of the duct. Cholangiectasia and purulent Cholangeitis. A small nodule at the serous surface of the pylorus. Arthritis ulcerosa sicca.

Microscopically:

Tumor at bifurcation of hepatic duct: adenoma malignum.
Nodule at pylorus: accessory pancreas.
Douglas: free.
Lymphatic glands: free.

CASE 3. Autopsy No. 1097–1909. Male cadaver, very poorly nourished; 72 years old.

Hypertrophy of the left ventricle. Parenchymatous degeneration of the heart muscle. Insufficiency of the aortic and pulmonary valves. Pleuritic adhesions on both sides, especially dense on the right. Fibrous scars on both apices of the lungs. Emphysema, purrulent bronchitis. Œdema of the left lower lobe. Fresh fibrous pleurisy of the right side and bronchopneumonia of the right lung. Colloid goiter in the right lobe of the thyroid gland. Adhesions around the spleen. Chronic interstitial nephritis. Anæmia of the kidneys. Small nodule of the right kidney. Trabecular hypertrophy of the urinary bladder. Ulcerated carcinoma of the pylorus. Metastasis in the lymphatic glands of the small curvature. Adhesions around the gall-bladder. Metastasis in the liver.

Microscopically:

Tumor of the pylorus: adenocarcinoma.
Metastasis of the liver: adenocarcinoma.
Lymphatic glands: adenocarcinoma.
Nodule of the kidney: fibroma.
Douglas: free.

CASE 4. Autopsy No. 1116–1909. Moderately nourished male cadaver; 67 years old.

Parenchymatous degeneration of the heart. Arteriosclerosis of the coronary arteries, of the mitral valves, of the bulbous aortæ and of the aorta. Strong adhesions of the pleuræ on both sides. Hyperæmia and œdema of the lungs. Anthracotic scar of the right lung. Catarrhalic bronchitis. Calcified goiter nodule in the right thyroid lobe. Free blood in the abdominal cavity. Acute soft tumefaction of the spleen. Chronic interstitial nephritis. Anæmia of the kidneys, atrophic sclerosis of the liver, and large sarcoma in the right lobe of the liver. Hæmorrhages into the mucosa of the stomach; small metastatic nodule in the stomach mucosa. Sarcoma of the portal glands in the region of the right suprarenal capsule and the capsule of the right kidney. Small nodule in the jejunum, enteritis. Hydrocephalus internus and atrophy of the brain. Softening in the head of the left nucleus caudatus. Chronic leptomeningitis cerebralis. Arteriosclerosis of the basal cerebral vessels.

Microscopically:

Nodules in liver and stomach: spindle-cell sarcoma.
Nodule in jejunum: accessory pancreas.
Portal glands: spindle-cell sarcoma.
Douglas: free.

CASE 5. Autopsy No. 1141–1909. Small female cadaver, most poorly nourished; 54 years old.

Hydropericardium. Fatty degeneration of the heart. Hypertrophy of the left ventricle. Hydrothorax. Slight pleuritic adhesions on both sides. Fibrous scars in both apices. Œdema of the left lung. Slight bronchitis. Slight ascites. Old scar from an infarct in the spleen. Dilatation of the pelvis of the right kidney. Thrombosis of the veins of the left kidney. Chronic interstitial nephritis. Ulcerated carcinoma of the pars pylorica of the stomach. Enlargement of the lymphatic glands in the left fossa supraclavicularis. Carcinomatous infiltration of perihepatic lymphatic glands and of those around the aorta. Adhesions around the flexura coli sinistra. Similar ones around the gallbladder and liver. Corset liver and atrophy of that organ. Perisalpingitis with occlusion of the tubes. Peri-oöphoritis.

Microscopically:

Pyloric tumor: adenocarcinoma.
Metastasis in lymphatic glands: adenocarcinoma.
Douglas: free.

CASE 6. Autopsy No. 1145–1909. Pretty poorly nourished male cadaver of medium size; 57 years old.

Dilatation of the left ventricle. Fatty degeneration of the heart muscle. Slight sclerosis of the coronary arteries, and of the mitral and aortic valves. Adhesions of both apices of the lungs, on both sides flat fibrous scars. Œdema of both lungs. Arteriosclerosis of the aorta. Soft tumefaction of the spleen. Chronic interstitial nephritis, and acute parenchymatous degeneration. Large ulcerated carcinoma of the pylorus with metastasis in the lymphatic glands of the head of the pancreas and at the small curvature.

Microscopically:

Pyloric tumor: scirrhus.
Metastasis lymphatic gland: scirrhus.
Douglas: free.

CASE 7. Autopsy No. 1148-1909. Pale, poorly nourished male cadaver; age not ascertained.

Carcinomatous stenosis of the left main bronchus, to a smaller degree of the right one also. Carcinomatous infiltration around both bronchii, and in the bronchial glands. Metastasis in both pleuræ. Obliteration of the right pleuræ. Bronchitis purulenta. Pneumonia of the right lower lobe. Tracheitis catarrhalis. Carcinomametastasis in the liver and in both kidneys. Metastasis in the head of the pancreas, and mesenteric and retroperitoneal lymphatic glands. Gastro-enteritis.

Microscopically:

Bronchial and peribronchial infiltration } large
Liver nodules } cell
Pancreas nodules } carcinoma
Metastasis in lymph glands }
Douglas: free.

CASE 8. Autopsy 1152–1909. Female cadaver of medium size and not very strong build; 42 years old.

Hypertrophy of both ventricles. Adhesions of both pleuræ and fibrous scars in both apices of the lungs. Hyperæmia of the left lung. Right upper lobe littered with atelectatic places, middle and lower lobe with tumor masses. Bronchopneumonia on both sides. Compression and stenosis of the right main bronchus. Purulent bronchitis. Catarrhalic tracheitis. Metastasis in the mediastinal tracheal and bronchial lymph glands. Metastatic nodules in the thyroid gland. Tumor infiltration of the lymphatic glands at the porta hepatis, at the stomach, pancreas, and aorta. Metastasis in the right lobe of the liver, in the pancreas, in both suprarenals and in the right kidney. Metastasis in the mucosa of the small intestines. Light parenchymatous nephritis. Slight gastro-enteritis. Ulcus rotundum the size of a 25 cent piece in the midst of the small curvature with perforation of the wall, and adherent to the pancreas. Adhesions around the gallbladder. Perisalpingitis and oöphoritis with occlusion of both tubes.

Microscopically:

Bronchial tumor and all metastasis: small celled carcinoma.
Douglas: free.

CASE 9. Autopsy No. 1171–1909. Moderately large, female cadaver, 56 years old.

Hypertrophy of the left ventricle. Sclerosis of the mitral and aortic valves, coronary arteries and aorta. Fibrocaseous tuberculosis of the apex of the right lung. Adhesions of both pleuræ. Carcinoma of the pars pylorica of the stomach. Carcinoma of the bronchial glands, and carcinoma of the lymphatic vessels of both lungs. Carcinoma of the tracheal and cervical lymph glands and of the glands around the aorta. Bilateral sclerosis of the kidneys. Chronic enteritis. Corset liver. Small calcareous nodule and brown atrophy of the liver. Atrophy of the ovaries. Small nodules in Douglas (carcinoma?) red bone marrow in femur, carcinomatous metastasis in the third thoracic vertebra.

In this case the find in the Douglas was positive, in the ovaries negative, and for this reason, I add to the anatomical diagnosis a somewhat more explicit description of the find in the abdominal cavity and of the microscopical examination.

Abdominal cavity. Appendix free; spleen, no particular change; kidneys are small, very hard, show granulated surface with extremely small cortex, and quite indistinct design.

Bladder, rectum, uterus, tubes, and vagina without any particular change; ovaries small and hard. In the Douglas are found smallest whitish nodules.

Stomach: The whole pyloric part is thickened and hardened, nodulous, and adherent to enlarged lymphatic glands surrounding it. On the cut surface the various tissue strata of the stomach-wall cannot be differentiated. A whitish gray, creamy juice can be scraped off from the cut surface. At the small curvature within these affected parts there is a round place bereft of its mucosa from which stripes of hardened tissue go out in all directions.

Intestines: the mucosa is everywhere thickened and reddened.

Pancreas and large biliary ducts: free.

Liver shows on the surface a transverse furrow, also a hard whitish nodule, the size of a pin head. The liver is small, soft, of brownish color, with indistinct lobular design. There are adhesions around the gall-bladder.

Microscopically:

Stomach. The normal glandular tissue in the mucosa of the stomach has entirely disappeared. A dense accumulation of connective tissue cells and fibers form a new tissue interspersed with a moderate amount of variably sized meshes. These meshes form nests foi numerous large roundish cells with dark colored large round nuclei. According to the size of the meshes the amount of the inclosed cells varies. Sometimes only two or three, sometimes more. The entire wall of the stomach till up to the serosa is filled with such nests. The muscular tracts are split up by the enclosures; and large nests with varying numbers of cells extend till directly below the intact serosa.

Cardia lymphatic glands. The glandular tissue appears only in some few places; instead one finds cells, quite similar to those of the tumor in the stomach, filling nearly all the space left open by the surrounding tracts of connective tissue.

Aortic lymphatic glands. Quite a similar picture as the glands of the cardia, but the carcinoma nests penetrate here nearly to the outermost limit of the capsule.

Lymphatic glands of the mesentery. Picture, similar to that of the cardiac gland.

Douglas: (1) Directly under and upon the serosa larger and smaller clefts with cell-nests which show the same structure as those in the stomach. They are surrounded by a ring of one or two rows of endothelial cells, and are more or less distinctly walled off from the surroundings. Frequently they form a hump on the surface of the serosa, covered by a delicate lining of endothelium, in other places smallest particles of carcinomatous tissue adhere freely to the serosa. The nests penetrate with hose-shaped protrusions, often with varicose windings, into the deeper tissues, till close to the muscularis of the rectum, but never enter it in any place. (2) Posterior upper part is free. (3) The anterior upper part on the posterior surface of the uterus also shows no change.

Ovaries: 3 cm. long, greatest width 1.5 cm., about 1 cm. thick. The ovaries of all cases were longitudinally cut and sectioned in this plane. The examination shows that both ovaries are free from carcinomatous cells. The albuginea is not thickened. The medullary zone is narrow.

CASE 10. Autopsy No. 1178–1909. Very poorly nourished male cadaver; 39 years old.

Brown atrophy of the heart. Fibrous pericarditis. Adhesions of the pleura, particularly on the right side. About 400 cm. of liquid in the left pleura. Perforation of the diaphragm to the left of the hiatus œsophageus. Pneumonia of the left lower lobe with tuberculous nodules in the left lung. Abscess under the diaphragm, between stomach and pancreas, with perforation into the left pleura.

Slight digestive softening of the superior pole of the spleen. Slight interstitial nephritis. Large ulcerated carcinoma of the cardia. Dilatation of the œsophagus. Fistulous communication of the stomach with the abscess. Chronic gastritis.

Microscopically:

Stomach: carcinoma simplex.

Aortic glands, Douglas: free.

Nodule of the lung: tuberculosis.

CASE 11. Autopsy No. 1206–1909. Female cadaver, very stout, general icterus; 61 years old.

Fresh laparatomy wound. Choleoyato-jejunostomy. Dilatation of the left ventricle. Fatty infiltration of the wall of the right ventricle. Severe parenchymatous degeneration of the heart. Subendocardiac hæmorrhages. Arteriosclerosis of the aortic and mitral valves and the coronary arteries. Moderate sclerosis of the aorta. Slight adhesions of both pleuræ. Hyperæmia of the lungs. Severe catarrhalic bronchitis. Slight thickening of the perisplenitic capsule and tissue. Chronic parenchymatous nephritis with formation of cysts and acute parenchymatous degeneration. Slight trabecular hypertrophy of the urinary bladder. Chronic atrophic gastritis. Compression of the ductus choledochus from a scirrhotic carcinoma in the head of the pancreas. A hard lymphatic gland at the cardia. Dilatation of the biliary ducts. Large corset groove and fatty infiltration of the liver.

In this case which filled all conditions required in the first part of this paper for a proper decision of the pending question of implantation, I was fortunate enough to find with a macroscopically absolutely normal peritoneum microscopical carcinomatous implantations in the Douglas excavation. Following is the more detailed report of the autopsy of the peritoneal cavity and the exact microscopical find of the relative parts:

Abdominal cavity. Peritoneum; everywhere glossy and moist. The gall-bladder is united by a Murphy button with a loop of the small intestines about 1 m. below the duodenum. The large biliary ducts are all very much dilated, everywhere in their entire course freely permeable, the pancreatic duct likewise. Below the papilla duodeni, in the head of the pancreas, is a hard nodule, as large as a good sized walnut, its cut surface showing a grayish white color and obstructing by compression the ductus pancreaticus, and the biliary ducts. At the cardia a very hard gland the size of a bean.

Spleen is small and flabby.

Kidneys are small, pretty hard, irregularly granulated on their surface, the design after bisection indistinct.

Ovaries, tubes, uterus, vagina, urinary bladder, rectum, without any evident change.

Ovaries. Right 3.5 cm. long, 1 cm. thick; largest width, 1.6 cm.; surface smooth.

Liver shows a horizontal groove, is large and flabby, the design indistinct, color yellowish brown.

Stomach and intestines. The mucosa of both is reddened and thickened.

Mesentery without any particular change.

Red bone marrow in the femur.

Microscopically:

Pancreas. The fully walnut sized nodule is on its outside surrounded by a thin layer of unchanged glandular tissue and surrounded by the normal serosa. Within the region of the new growth there are here and there sparse remnants of the glandular tissue, which is in other places largely substituted by dense connective tissue. The fascicles of connective tissue leave small meshes between them which contain variable accumulations of two, three, and more large, round, blue-stained cells. The cells are mononuclear. In some instances indications of karyokinesis or polynuclear cells. The nuclei are stained a deep blue. In many places the poorly stained connective tissue cells are loosened and swollen. Their outlines are indistinct, and they surround irregular formed cavities of varying size which contain besides cell detritus, blue stained soppy cells with indistinct nuclei, among them also the well known forms of sealring cells.

Hard lymphatic gland at the cardia. The tissue is composed of intertwining wavy, irregularly placed cell-strands which cross each other in all directions, and consist of narrow spindle-formed cells with an eosin red plasm and longitudinal narrow, deep-blue nuclei. The outer membrane is formed by a thin endothelial cell layer of large polygonal cells with round nuclei. The "hard gland" shows up to be a subserous myoma of the wall of the stomach.

Aortic lymphatic glands: free.

The regular small celled lymphatic glandular tissue is of a perfectly normal composition, and without any foreign constitutent.

Mesenteric lymphatic glands. The identical find as in the aortic glands is seen.

Douglas: (1) Bottom of pouch. Upon the serosa surface and in its innermost layer are foci of cells of varying sizes (Fig. 1, h). The smallest of them contain only two or three cells and their number increases until the largest contain a hundred and more cells. They are the mates of those found in the tumor of the pancreas. Frequently one sees small accumulations of the cells in the form of a hump lying upon the serosa (e), lined by a delicate layer of endothelial cells which merges in its continuation with the serosa. In some of the sections one observes smallest particles of carcinomatous cell tissue (br) consisting of large cells, lying free upon the smooth serosa surface (a, Fig. 2) apparently adhering to it more or less firmly. Where there are larger masses, they are exclusively located closely to the outer surface of the serous lining, farther inward only small and smallest foci are present, consisting of a few cells only, or these layers of the serosa (t, Fig. 1) are entirely free. In the subserous tissue (sb) no cell accumulations can be found at all, nor are any to be seen in the adjoining muscularis of the rectum (Fig. 3, m). (2) The anterior reaching about 1½ cm. (3) The posterior parts of the Douglas excavation reaching about 1 cm. above the bottom of the pouch are entirely free from carcinoma.

Ovaries. The examination shows entirely normal conditions. Corresponding to the age, the albuginea is somewhat thickened, in the stroma very few follicles only. The medullary zone atrophic. Both ovaries entirely free from carcinoma.

CASE 12. Autopsy No. 77-1910. Poorly nourished female cadaver; 55 years old.

Fresh laparotomy wound. Drainage of the upper jejunum. Bronchopneumonia in the left lower lobe. Atrophy of the spleen. Chronic interstitial and parenchymatous nephritis, and slight dilatation of the pelvis of the right kidney. Infiltrating carcinoma of the pars pylorica of the stomach. Metastasis in the lymphatic glands around the stomach. Slight fatty infiltration of the liver. Fresh hæmorrhages in the corpus uteri. Adhesive perimetritis. Small nodules (carcinoma?) in the Douglas.

Microscopically:

Stomach (a piece of the wall of the pylorus about 1½ cm. in size). The glands of the stomach are not distinguishable any more. The mucous membrane is entirely permeated with nests of moderately large roundish and oval cells, with large nuclei. The mucosa is infiltrated with numerous round cells. The carcinomatous nests fill the entire muscularis but nowhere is there an involvement of the serosa. All the lymphatic glands (of cardia, aorta, and mesentery) show metastatic foci.

Douglas's pouch. Great infiltration of the serosa with round cells. In the interspaces of the connective tissue are small nests of carcinoma irregularly distributed, and filled with cells similar to that of the growth in the stomach. They are spread through the entire thickness of the serosa, but do not go any deeper.

The parts of the Douglas joining the pouch on either side posteriorly and anteriorly are free.

Ovaries: free of carcinoma.

CASE 13. Autopsy No. 89-1910. Poorly nourished female cadaver; 50 years old.

Slight hypertrophy of the left ventricle. Light parenchymatous degeneration of the heart. Arteriosclerosis of the aorta. Œdema of both lungs. Catarrhalic bronchitis. Extensive adhesions of the right pleura. Base of the tongue rather smooth. Parenchymatous nephritis. Chronic cystitis. Cyst in the right suprarenal capsule. Cysts in the nodules in the omentum. Adhesions of the liver to the diaphragm. Primary tumor and multiple metastatic tumors of the liver. (Weight of the liver about 4,200 gr.) Small corset lobe of the liver. Multiple metastasis of both pleuræ, also on the abdominal surface of the diaphragm in the omentum (?) and on the right suprarenal capsule. Small hæmorrhagic metastasis in the wall of the stomach. Chronic hyperplastic gastritis. Metastatic nodules in the anterior and very small ones in the posterior Douglas. Fibroid of the anterior wall of the uterus. Adhesions in the posterior Douglas.

Microscopically:

Circumvascular sarcoma (angiosarcoma) of the liver. Small nodules in the stomach. Metastasis in both pleuræ, right suprarenal capsule in the Douglas all of the same structure as the liver tumor. No metastasis in

the lungs and in the lymphatic glands of the omentum.

The ovaries are free. A small nodule of the kidney proves to be a fibroma.

CASE 14. Autopsy No. 129–1910. Very poorly nourished female cadaver; 76 years old.

Very marked kyphoscoliosis. Hypertrophy of the left ventricle. Parenchymatous degeneration of the heart muscle. Arteriosclerosis of the mitral and aortic valves. Sclerosis of the coronary arteries, and of the aorta. Adhesions of the right pleura. Hypostasis and moderate œdema in the left lower lobe. Purulent bronchitis. Anthracotic cicatrices of the apices of the lungs. Adhesions around the spleen. Chronic parenchymatous, nephritis with slight shrinkage. Cystitis. Dilatation of the urinary bladder. Atrophy of the mucous membrane of the stomach. Ulcerated carcinoma of the cardia. Metastasis in the jejunum. Corset liver, and moderately fatty infiltration. Perihepatic adhesion. Apoplexia uteri. Adhesions around the tubes and ovaries; occlusion of the left tube. Deposits in Douglas's pouch.

Microscopically:

Stomach: large-celled carcinoma.

Douglas deposits: fibrin; not carcinoma.

CASE 15. Autopsy No. 129–1910. Medium large female cadaver; general icterus; 35 years old.

Hypertrophy of the left ventricle. Parenchymatous degeneration of the muscle of the heart. Hypostasis and atelectasis in both lower lobes; the same in the right middle lobe. Parenchymatous degeneration of the kidneys. Acute cystitis. Carcinoma of the pars cardiaca of the stomach: acute gastro-enteritis. Carcinomatous infiltration of the ductus choledochus and cysticus, also of the wall of the gall-bladder. Metastasis of the mesenteric retroperitoneal glands and in the pancreas. Carcinoma of the left ovary. Small carcinomatous nodules in the Douglas.

Microscopically:

Stomach (a piece about 1½ cm. large through the entire thickness of the wall of the stomach from the seat of the tumor in the region of the cardia): The mucous membrane shows a total absence of glands in the tissue. The mucosa is largely impregnated with various sized foci of small round cells which lie embedded in the meshes of connective tissue. The whole muscularis is also filled with these nests. Serosa intact, lymphatic glands show metastatic affection with similar nests of small round cells.

Douglas: Bottom of pouch. The serosa is largely filled with small and medium sized nests of cells of the new growth, which fill pretty equally distributed, the whole thickness of the serosa, and also penetrate in isolated places the uppermost layer of the subserous cellular tissue.

The higher parts of the Douglas anteriorly and posteriorly show the same pathological changes.

Left ovary: The stroma is impregnated with small and larger nests of carcinomatous cells, which are divided into alveolar spaces by thick and thinner tracts of connective tissue. The medullary substance also contains similar foci. The albuginea contains small masses of cells and in some very much thickened places larger ones.

Right ovary: Very large development of connective tissue in the stroma, but no carcinoma.

If we now sum up what the examination of these cases has taught us we have doubtlessly ascertained from the first that (case 11) a macroscopically absolutely normal Douglas may contain microscopically visible metastasis of carcinomatous tissue. We have further seen, that aside of the last case (case 15) in which we found widely disseminated glandular metastasis and an advanced metastatic tumor of the left ovary, three cases (case 9, 11, 12) showed the metastasis at the lowest point of the Douglas exclusively, while the anterior and posteriorly higher located parts of the adjoining peritoneum were free, notwithstanding that in two of these cases (cases 9 and 12), macroscopically visible changes were already present and the examination showed that the carcinomatous growth had already penetrated far into the subserosa.

In the only case of my series entirely free from objections (case 11) which represents the earliest stage of the carcinomatous metastasis in the Douglas, and therefore was decisive for its genetic determination, the road between the primary tumor and the metastasis in the Douglas was as far as it is possible to ascertain entirely free of way-stations.

The body, thought at first to be an enlarged metastatic and lymphatic gland of the cardia, the examination disclosed to be an innocent subserous myoma of the stomach. The lymphatic glands of the mesentery and of the aorta were here entirely free.

In this same case the carcinomatous metastases were limited entirely to the surface and the most superficially situated parts of the serosa (compare Figs. 1 and 3), nay, in this case as also in case 9, we could even demonstrate some particles of carcinomatous tissue (Fig. 2) which adhered to the free surface of the serosa.

Taking all these points together, we see the only possibility of a clear explanation, in the acceptance of an implantation from the primary tumor, an implantation for which according to the law of gravitation, the Douglas with its pouch as the lowest point offers the most favorable opportunity. Going further, case

11 also proves the assertion that a carcinoma, located in the upper part of the abdomen, and which has not perforated the serosa, but on macroscopical inspection shows a perfect incapsulation within the organ it occupies, may cause implantation in the Douglas. We have here a nodule in the head of the pancreas which not even shows an attempt of perforation through the serosa. From here an implantation can only have taken place through the lymphatic interspaces of the radix mesenterii or of the mesocolon transversum.

It is true I cannot tell anything in this respect about the state of the mesocolon transversum and the radix mesenterii. These various parts of the peritoneal tissues were not included in the original frame of our investigation. This however, after the result of the rest of the findings is entirely irrelevant to the principle involved, and we must, from the analysis of this case, hold the possibility of carcinomatous seeds passing through the intact serosa and capable of implantation, completely assured.

The examination of the series shows further that the Douglas, as was to be expected on account of its deep location, is more frequently and earlier affected than the ovaries. How far the relations existing here must be modified by larger numbers cannot be predicted. It was sufficient for us that we could prove the principle as such, which secondarily surely confirms, also for the ovaries, the possibility of implantation of carcinomatous seeds.

According to our opinion, we can now draw from our examinations the practically important conclusion, to consider the Douglas in radical operations for carcinoma of the organs in the abdominal cavity. Sitzenfrey (17) recommends the extirpation of the sound ovaries in carcinoma of the stomach. As a logical sequence of carrying through the radical principle of the operative treatment of carcinoma, I should recommend the extirpation of the lowest part of the Douglas, i. e., of the pouch in these cases.

I would draw the following conclusions as the result of these examinations:

1. Carcinoma in the abdominal cavity may cause an implantation metastasis in the Douglas.

2. It occurs earlier than that of the ovaries.

3. It is influenced in its origin by the law of gravity and therefore affects first the deepest part of the Douglas, i. e., the pouch.

4. It is not necessary in these cases that the primary carcinoma has perforated into the free abdominal cavity; a carcinoma still entirely covered by serosa can cause implantation by metastasis of the Douglas.

5. It should be recommended in radical operation of carcinoma of the organs in the abdominal cavity to remove the deepest situated part of the Douglas, i. e., the pouch.

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THE INFLUENCE OF TRAUMA IN THE PRODUCTION OF DISEASES OF THE PELVIC ORGANS IN WOMEN

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IT is a common occurrence for women who arehurt in railway accidents to claim injury to the pelvic organs in some form or other.

In order to present some definite information on this subject, I have carefully analyzed the last one thousand cases of railway accidents that have come under my personal supervision.

These persons were all said to have been injured on our local surface or elevated street car lines. Of this one thousand cases, five hundred and thirty-eight were men, four hundred and twelve women, and fifty children. Eliminating the men and children, we have the four hundred and twelve women for our consideration and of this number seventy-seven, or eighteen and seven-tenths per cent, claimed injury to the pelvic organs as a direct result of the accident.

As indicating the nature of the accident, it may be stated that thirty-nine of the women fell either on the back, side, or hands and knees, while alighting from cars, it being claimed in most cases that the car started with a jerk and threw them; one however, fell by reason of stepping in a hole in the pavement, and another by reason of her ankle turning and causing her to sit down on her heel; eleven were injured by being thrown about in cars due to collisions with other cars or wagons; six fell or were dragged while trying to get on moving cars; six were struck and knocked down by cars while standing or walking on the street; four were thrown from vehicles struck by cars; two were injured while trying to escape in fright from cars supposed to be ablaze; two were thrown about by reason of the car stopping suddenly due to striking against an obstruction; one was injured by reason of the car jumping the track; one jumped from a moving car; one fell from the steps of a moving car; one fell inside the car due to a sudden jerk; one was thrown against the car door as the car started and received a fright without physical injury.

Of the seventy-seven women claiming injury to the pelvic organs, seventy-two were married and five single. This phase of the question will be taken up later.

In attempting to classify the effects of the accidents, we find that in twenty-four cases a miscarriage resulted. The youngest woman was twenty years old and had already had two children. The oldest was forty-nine and had also had two children. It is interesting to note that in all but one of the cases, the miscarriage occurred before the fifth month. The one case was a woman thirty-eight years old. She was five months pregnant when on June 11th she had a slight fall getting off a car. She was not badly hurt but got up and walked home and did not lay up at all. She flowed a little at the time and then again on August 28th, two and one-half months later, when she was delivered of a dead fœtus.

One woman miscarried as a result of fright without any physical injury. She was twenty-seven years old, had had three children and was one and one-half months pregnant when she became greatly frightened by a thunderstorm while riding in a car. She became very nervous, went home, and three weeks later miscarried. She was a neurotic with a flabby abdomen, double movable kidneys, laceration of the perineum, bilateral laceration of the cervix, and retroflexion of the uterus.

One woman, eight and a half months pregnant, who stepped in a hole and fell, getting off a car, ruptured the membranes and at least a part of the amniotic fluid escaped at once but labor did not come on for sixteen days, which of course brought her up to the full time. There was only one woman, so far as known, in the seventy-seven, who was pregnant less than five months, namely, one month, and who did not miscarry. This is in marked contrast to the fact that there were fifteen women not included in the seventy-seven, as no pelvic injury was claimed, but included in the four hundred and twelve, who were pregnant five months or more yet not one miscarried.

These facts indicate that miscarriage is

easily induced by injury or even fright during the early months of pregnancy but after the fifth month it is very rarely brought about in this manner. As practically all of these cases claimed in addition to the miscarriage, some permanent injury to the pelvic organs, it will be necessary to follow them out a little further. We find that one was examined five days after the accident and was still sick with her miscarriage, but there was no other injury present.

Seven were examined from four to eight weeks atter the accident and all had made good recoveries from the miscarriage.

One recovered from her miscarriage and was normally confined in less than a year thereafter. One had a baby at full term and was pregnant again five months at the time of examination, evidently not injured any by her miscarriage. One delivered of a dead fœtus two and one-half months after the accident was found in good health two and one-half years after the accident with nothing the matter that could be attributed to the miscarriage. One was found in good condition four years after the miscarriage and had had two normal confinements in the interval. One who miscarried on the third day was operated on on the twelfth day and two large intraligamentous cysts, one the size of a child's head, the other the size of two fists, removed. She was in good condition one and one-half years later.

One who had had twelve confinements and who complained of considerable suffering was found on examination four years later to have an extensive cancer of the cervix, evidently not due to the accident. One who received a fracture of two ribs on the left side miscarried on the sixth day, and was confined to her bed six weeks. She complained two and one-half years later at the time of examination, of pain in the chest and of headache and of pain in the uterus at menstruation, which was regular and lasted only two days. She was thin, pale, anæmic, underfed, and overworked, which condition amply accounted for her complaints.

One woman thirty-nine years of age and who had had three children, had a sick spell which laid her up nine weeks in bed about a year after the accident. The chief symptoms of the illness were referred to the abdomen and consisted of pain, soreness, and cramps. Her complaints, one and one half years after the accident were chiefly irregular menstruation, pain in the upper abdomen, and dizziness. Examination showed no tenderness or soreness about the pelvic organ but a marked visceral ptosis including the liver and stomach, a condition amply accounting for her symptoms.

One case examined two and one-half months after the accident was found to have an old laceration of the perineum and cervix with an enlarged, tender, inflamed uterus, the latter condition undoubtedly aggravated by the recent miscarriage.

The remaining four cases all had old lacerations of the perineum and cervix with retrodisplacement or prolapse of the uterus, and two of them in addition old, tender, movable right kidneys, conditions easily explaining all the numerous symptoms complained of and as the conditions all antedated the accidents the latter could not have been responsible for the former.

In summing up the miscarriage cases it will be noted that all of the women recovered, and most of them recovered without any permanent ill effects. In most of those cases presenting later symptoms, other conditions mostly antedating, and therefore independent of the accidents, were found which amply accounted for the symptoms, while in only a few of the cases could it reasonably be held that the miscarriage aggravated the old conditions present.

Of the non-pregnant women, twelve, in addition to the usual bruises incident to the fall, complained of disturbed menstruation. In ten this amounted to a slight irregularity for a month or two only, while in two, aged fifty years each, and who had passed the menopause, a slight hæmorrhage lasting a few days occurred.

Four women aged from forty-five to forty-eight years, who were examined some time after recovering from the primary effects of the accidents, complained of nervousness, pain in the back of the head, dizziness, poor vision, noises in the head, heat flashes up and down the back, palpitation of the heart, sweating, etc., symptoms readily recognized as common during the change of life, through which all of these women were passing at the time. Only one

of these women was badly injured at the time, and she received a fracture of the fifth and sixth ribs on the right side, a Colles' fracture of the right wrist, and a sprain of the left ankle.

One other woman also passing through the change of life, flowed freely for ten days, and developed a small, soft mass to the left of the uterus, in all probability a hæmatoma. Six women had passed the menopause some time. One aged forty-two years sustained a fracture of the right leg near the ankle and a bruise of the hip. She was in bed three months and around on crutches one year. She complained of pain in the right side of the pelvis, with a bearing down feeling. She had never been pregnant, and had ceased menstruating at the age of twenty-seven years. An examination showed a large, hard tumor filling the right side of the pelvis, which, it was learned, had been there since about nine or ten years before the accident.

One woman forty-nine years of age who received bruises of the knees and back from being thrown about in a car that had jumped the track, developed acute intestinal obstruction from volvulus and was operated on on the third day. She recovered nicely, but nine months later returned to the hospital and had the uterus, tubes, and ovaries removed for infected ovarian cysts, according to her doctor's statement. She has since suffered from nervous symptoms.

One woman sixty-seven years of age claimed to have sustained a large rupture as a result of her fall, but an examination showed it to be an old laceration of the perineum with a large rectocele the size of a good sized orange, evidently not due to her accident.

One woman aged forty-eight who was struck by a car and knocked down receiving bruises of the knees and a sprained wrist, claimed she discovered she had falling of the womb when she got up after a two weeks' stay in bed, but examination showed an old lacerated perineum with an offensive purulent discharge and a small uterus without prolapse.

One woman aged fifty-nine years claimed to have pain in the ovarian region, nervous symptoms, frequent urination, etc., due to a fall getting off a car. Examination showed an old laceration of the perineum nearly to the rectum; rectocele and vesicocele, retrodisplacement of the uterus, and albuminuria.

One woman sixty-four years old claimed pain and soreness in the pelvis with prolapse from a fall which did not lay her up at all. Examination showed an old laceration of the perineum with rectocele and vesicocele and prolapse for which she was wearing a pessary at the time. A single woman forty-six years of age, who sat down forcibly on her heel or a stone by reason of her ankle turning as she stepped from a car, on the third day developed a swelling on the right side of the vulva which later proved to be a cyst of the vulvo-vaginal gland. She had a bad leucorrhœa, at the time undoubtedly due to an infection.

In three women with old pus tubes, acute symptoms were set up which, however, subsided after a few weeks leaving them in about the same condition as before the accident. A woman forty-two years old, who fell on her right side while getting off a car, developed soon after, severe pain in the abdomen with fever, vomiting, constipation, etc., and on the seventh day at operation, a large ovarian cyst the size of a child's head was found, with a twisted pedicle. She made a good recovery.

A woman thirty-one years old fell getting off a car, bruising her right arm and head. She was in bed two weeks and on getting up complained of pain in the left side of the abdomen and pelvis. Shortly thereafter she was operated on to correct the retrodisplacement of the uterus by shortening the round ligaments. Two years later she complained of painful menstruation which she attributed to her fall. Examination showed the operation had not been successful, as the uterus was retroflexed. She also had a movable right kidney.

A woman thirty years of age struck the left side of her head and abdomen against the door of a car. She was in bed one week with pain in the abdomen. A year later she still complained of pain in the abdomen, pelvis, and back, and of occasional vomiting. Examination showed she had been operated on about eight years before for an abdominal tumor and a ventral hernia developed soon thereafter which readily accounted for her pains, etc.

A woman thirty-two years old who had had three children was nursing a baby at the time she fell getting off a car, and had not menstruated for eight or nine months. She began flowing soon after and flowed for six weeks, and claimed excessive menstrual flow from that time. Examination showed a retrodisplacement with chronic endometritis.

A woman of forty-five years was struck and knocked down by a car. She began flowing, although she had menstruated but a week and a half before, and flowed ten days. The next period lasted but three days and was natural. She complained of pain in the left ovary and back and of numbness, coldness, and lameness of the left leg, all nervous symptoms, as nothing but slight tenderness of the left ovary was found on examination.

A woman of twenty-eight years, who had had four children, was pregnant six months at the time of the accident. She was not badly hurt but remained in bed six weeks fearing a miscarriage. One did not occur, however, but she was confined on time without any trouble. About four months later she miscarried at six weeks, and was quite sick as a result for about six weeks. Following this she was treated for womb trouble for a year or more, and then had a baby at full time. After this history it was ridiculous to attribute her pelvic symptoms of which she complained some six months later, to her fall more than two and one-half years previously.

A woman twenty-five years old was thrown out of a buggy and dragged some distance by reason of a col-

lision with a car. The skin of the left buttock and perineum was denuded and dirt ground in the wounds. She was pregnant eight months and seven days. The membranes ruptured and the waters escaped but labor did not come on until three weeks later at full time. It was a dry labor. Sepsis developed on the third day, with thrombosis of the femoral vein or so-called "milk leg," and she was still sick abed when examined six weeks later, but eventually recovered.

A woman twenty-six years old who had had six children, the last but three weeks before her fall getting off a car which caused no special injury, began flowing at once and flowed eight to ten days. She then complained of a throbbing pain in the right side of the pelvis. An examination showed an extensive tear extending well up to the left side of the uterus with an enlarged, tender, and prolapsed ovary, a condition evidently not due to her fall.

An unmarried woman aged twenty-seven years was jarred forward then backward in her seat striking her sacrum. She was not laid up at all but complained of pain in the lower part of her back, and nervousness, and had quite a leucorrhœa. One month later she went to a hospital where her uterus was curetted, the appendix and part of both ovaries removed, and an operation done to correct a displacement of the uterus. It is certain this woman had been infected before, as the conditions found at the operation could not have resulted from so slight an injury in so short a time.

An unmarried woman, twenty-one years old, fell alighting from a car, striking on her left hip and back. She was taken home and went to bed, next day began to flow one week in advance of the regular time. Claims to have remained in bed six weeks flowing all the time, and remained in the house three months taking douches daily. She then went to a western state and remained three months. Was around all right there and had no medical treatment whatever during that time. She then returned to the city and claimed permanent injury to the left hip with wasting of the left leg, fracture of the coccyx, pain in the pelvis, irregular painful menstruation, and prolapse of the left ovary. Examination showed no injury to hip, no wasting whatever of left leg, no fracture of coccyx, and no prolapse of ovaries. It also became evident from the examination and subsequent investigation that she was a miss in name only, and a fraud.

Another unmarried woman aged twenty-one years fell in getting off a car. She was taken home in an ambulance and claimed one or two ribs were fractured. Although unmarried, she was pregnant six months at the time. She did not miscarry, but on account of her other injuries and her confinement, which occurred at the regular time, she was in bed four months. She got married, and about five months after her normal confinement she had a miscarriage, and another one about six months later. She then claimed pelvic pains, backache, painful, irregular menstruation, etc., all due to the fall some two years before. An examination showed a posterior displacement with double chronic salpingitis, which her history made clear were not due to the accident.

A seventeen year old girl struck the small of her back against a car seat during a collision of cars. She got out and walked to her place of work. Feeling some pain and soreness later, she called a doctor, who found a bruise to the left of the spine just above the ilium. She rested in bed two weeks. Ten days after the fall she menstruated, which was a few days in advance of the regular time and was more painful than usual. The next two periods were slightly irregular, after which she was better.

A woman thirty-eight years old with two children, fell and was dragged some distance while trying to get on a moving car. She fractured her nose and had great pain in the left side of the chest and abdomen. She had menstruated ten days previously but began to flow at once and continued for eleven days after which a seropurulent discharge showed. Soon after the fall an examination showed a boggy fullness to the left of the vaginal vault, probably a hæmatoma. No later examination was permitted.

A woman twenty-six years old fell getting off a car. She was pregnant three and one-half months and began to flow at once. She went to a hospital where she remained nine days, flowing most of the time. She then went home and flowed some off and on for six weeks, when she was taken to another hospital and operated on by laparotomy, and an old ruptured extra-uterine pregnancy removed. Recovery ensued without incident.

We have remaining eleven cases which are so similar that they may be grouped together. They were all married women who had borne children. The injuries were the usual bruises with the addition of a dislocated shoulder in one and a fractured rib in two. After getting around they all complained of the usual symptoms, namely, pain in the back, lower abdomen, and pelvis, bearing down, irregular menstruation, old lacerations of the perineum and cervix, posterior displacements with chronic endometritis. In one, the laceration extended to the rectum, two had in addition, badly movable right kidneys, and in one the uterus was flexed by adhesions to an old enlarged right tube.

In all of these cases the late symptoms were all easily explained by the old conditions found, none of which could be attributed to the injuries received.

In reviewing these cases, it should be understood that attention has been directed entirely to the pelvic organs. Most of the women, of course, received the usual bruises incident to a fall, and some of them more serious injuries, such as dislocation of the shoulder, fracture of the wrist, leg, ribs, nose, scalp wounds, con-

cussion of the brain, etc., from which injuries, however, all of the women recovered.

It is perfectly plain that many of the conditions found, namely, old lacerations, rectoceles, cystoceles, prolapses, old displacements, intraligamentous cysts, pelvic tumor, etc., bore no causal relation to the accidents; on the other hand, it is equally plain that the ruptured extrauterine pregnancy, the acute volvulus, the twisted pedicle of the ovarian tumor, the pelvic hæmatoma, the miscarriages, etc., were the direct result of the accidents.

The chief question is whether intrapelvic diseases such as salpingitis, metritis in its various forms, displacements of the ovaries and uterus, etc., can be caused or initiated by such accidents as have been described above.

Of much interest and importance in this connection is the married or single state of the women to which attention was directed early in this paper. Of the four hundred and twelve women injured, three hundred and thirty-one were married and eighty-one single.

Of the seventy-six women claiming some form of injury to the pelvic organs (eliminating the one who merely injured her vulva by sitting down on her heel) seventy-two were married and four were single, but of these four, three were single in name only as one was pregnant at the time and two showed unmistakable signs of marital relations, and one of them certainly had an old infection, thus, only one was actually a miss and the only pelvic disturbance she had was a slight irregularity of menstruation for two or three months.

We find then, that of the married women twenty-two per cent claimed injury to their pelvic organs, while of the actually single only one per cent had a temporary disturbance of menstruation.

The inferences to be drawn from these facts are, that women with normal, healthy pelvic organs very rarely indeed have these organs injured by such accidents as have been described above, while those whose organs have been damaged by the violence of parturition or from the effects of previous infections, may have former symptoms temporarily aggravated or acute exacerbations of old infection renewed.

From the foregoing presentation of cases, I wish to draw the following conclusions:

First. Miscarriages during the first four months of pregnancy readily occur, often from comparatively slight injuries or even fright, but after the fifth month, they very rarely occur from such causes.

Second. Such accidents as have been detailed above very seldom, if ever, cause disease or displacement of the pelvic organs in women whose organs are normal and healthy at the time of the accident.

Third. Women with chronic pus tubes or other pelvic inflammations may have acute exacerbations of their troubles excited by accidents producing general injuries.

Fourth. Women with old lacerations, displacements, prolapses, etc., may have the symptoms resulting from such conditions temporarily aggravated by general injuries and are often particularly prone either consciously or unconsciously to attribute all of their troubles to such injuries, which had little or nothing to do with causing the conditions present.

Fifth. Accidents producing general concussion of the body may produce a temporary irregularity in the menses, usually increasing them but occasionally suspending them, which functional derangements seldom last longer than three or four months.

DIAGNOSIS OF HYPERTHYROIDISM OR EXOPHTHALMIC GOITER

By C. H. MAYO, M. D., Rochester, Minnesota
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THE ancient history of hyperthyroidism or exophthalmic goiter amounts to a rather imperfect description of the disease by several observers of a few cases each. The condition was formerly considered as purely medical and the knowledge of existing conditions was derived solely from autopsies which necessarily presented many changes in structure throughout the body which was not present in the early stages of the disease. In fact the condition of the thyroids did not seem to call for any unusual attention as compared to other organs because macroscopically they often resembled enlarged thyroids of the simple type.

For the past fifty years clinicians, who have based their knowledge upon symptoms and upon terminal changes as found at autopsies, have endeavored to classify certain cases of goiter within the narrow limits of the description of the few cases reported by those remarkable men, Parry, Graves, Basedow, and others nearly a century ago.

To-day even with the great progress in medical science we are lacking very much in our knowledge of the subject. Formerly only such cases as presented all the symptoms in a severe form were accepted as Graves' disease. The belief that the disease represents a condition *sui generis* and thereby differs from nearly all other diseases, still prevails among many members of the medical profession. They pronounce well marked cases as *fruste* or *pseudo* until the eyes become prominent. Should that feature have been delayed, even if all other symptoms are present it is not until this condition appears that they are properly labeled as a disease, after all representing but a syndrome of symptoms. Figs. 1, 2, and 6.

It is now definitely shown that the condition is not one which involves all the organs at the onset, but that it is like other diseases in presenting acute, chronic, mild, severe, and irregular or remittent types of the disease.

In the development of the surgery of simple goiter during the last thirty years, many patients have been operated upon who either had at the time of operation or previously, many if not all the symptoms of exophthalmic goiter. If symptoms of hyperthyroidism were the main indications for operation, the cases were classified accordingly, otherwise they were considered as simple or encapsulated goiter with partial or temporary hyperthyroidism.

Results of the accumulated knowledge in the examination of all forms of thyroid disease the world over, is that there is a definite increase in the parenchyma of the gland in all forms of exophthalmic goiter, with evidence of over activity of cell secretion. This evidence may present itself in several ways, (*a*) increase of cells in the alveoli, (*b*) increase in the number of alveoli, (*c*) by papillomatous invagination into the vesicles of the gland. All of these changes may be throughout the gland or only in areas of it. Pathologists who are experienced in this class of laboratory work are usually able to give the symptoms and stage of the disease from a typical microscopic slide, and, from the form of the degeneration of the tissues in some cases can estimate the probable condition of the heart, liver, and essential organs.

It seems probable that a thyroid which presents this condition of hyperthyroidism and does not destroy the life of the individual or destroy itself, must at some period of its activity, revert back to simple goiter. Then colloid will be deposited with iodothyroglobin and the gland will lose its apparent cell activity.

From the examination of a great many thyroids of this type it would appear that this change or reversion may appear at any period, and that certain exceptional individuals are able to withstand the disease until there is a degeneration of the parenchyma and positive loss of secretion or hypothyroidism, shown by varying degrees of myxœdema as a terminal condition following former hyperthyroidism. There may be wide variations in the quantity of thyroid secreted in simple and cystic goiters within the limits of health. Theoretically

Fig 1 Fig. 2. Fig. 3 Fig. 4.

Fig. 1. Hyperthyroidism with little glandular enlargement and no exophthalmos.
Fig. 2. Hyperthyroidism with thyroid enlargement but no exophthalmos.
Fig. 3. Hyperthyroidism with little glandular enlargement but marked exophthalmos.
Fig. 4. Hyperthyroidism with both thyroid enlargement and exophthalmos marked.

in the one case there should be hypothyroidism, in another, hyperthyroidism, yet neither of these conditions can be constantly recognized. The break in the equilibrium of the associated ductless glands to produce hyperthyroidism under such conditions, is seemingly brought about in the majority of cases by some infectious disease or severe illness, although a considerable number of cases exhibit the first symptoms through a change in the nervous system following a severe mental shock.

Fig. 5. Hyperthyroidism, terminal results: Chronic toxæmia not abated but leaving myocardial and general degenerative changes.

In fact there has been but little added recently to our knowledge of the etiology of simple goiter, and concerning that of exophthalmic goiter, much is written and little is known. Heredity appears to be an important factor in some cases. We still lack the knowledge as to whether the stimulus is from within or without as a chemical irritant or hormone. The gland elaborates iodine of which there is less in the gland of hyperthyroidism than in the normal gland, but Ried Hunt has shown that in such cases there is more iodine in the blood, it being produced, delivered, and slowly excreted from the system contrary to its usual rapid elimination. It is also shown by Marine and others that colloid goiter contains more iodine in the whole gland than in the normal thyroid, but bulk for bulk the colloid goiter contains less iodine than normal thyroid. It is possible that colloid is capable of holding the secretion of the gland without suffering destruction, and in the retention of the secretion with colloid, the size of the thyroid is necessarily increased. Marine believes that hyperthyroidism is induced by a lack of some essential secretion of the thyroid considered as a complex substance, and in the effort to restore this, an excess of some component part of the secretion is produced to a toxic degree.

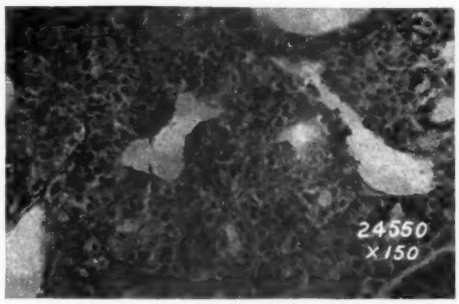

Fig. 6. Exophthalmic goiter.

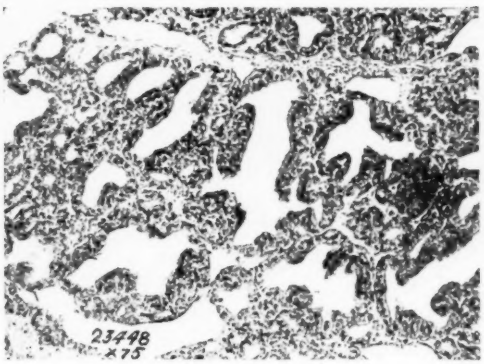

Fig. 7. Papillomatous increase. Secondary hyperthyroidism following primary simple goiter.

Reviewing briefly the most important manifestations of hyperthyroidism we have tachycardia as the most usual heart condition. In advanced cases the heart may be irregular in rhythm, and the pulse of low tension. Dilatation of the heart must be differentiated from dilatation with hypertrophy and compensation, and from pure myocardial disease as well.

The eye symptoms are numerous and may appear early or late, and one and all of them may be present. These symptoms consist of: prominence, a widening of the palpebral fissure (Dalrymple), staring without winking (Stellwag), lagging of the lids with eye movements (Graeffe), insufficiency of accommodation at near point (Mobius). Rarely there is dislocation of the globe. Ulcer of the cornea is not uncommon in marked cases. Myocardial changes and Bright's disease may also produce some of these symptoms.

Tremor is nearly always present; eight or nine to the second, and may be associated with chorea-like movements in extreme cases with, as a rule, great muscular weakness. Figs. 3 and 4.

As to goiter: The thyroid may be but little enlarged in the early cases, or enlargement may be the first symptom. If it is present a long time previous to the onset of Graves' disease, the microscopic changes will be parenchymatous increase of cells projecting into the colloid retention in the vesicles. From these cells the secretion is derived. Operative deductions from certain cases would indicate that a wonderful cell increase may occur with but little enlargement of the thyroid as a whole, and it is apparent that the secretion is delivered and not retained. Fig. 7.

The general symptoms are sweating, anæmia, emaciation, and loss of strength in the majority of cases. Vomiting and diarrhœa without apparent cause are common but transient symptoms. Pigmentation of the skin is often seen and a bronzing is not unusual. Urine small in amount. Albumen is found occasionally in many cases. Patients in advanced conditions may have it in considerable amounts, as well as the hyaline and granular casts. Transcient glycosuria is often noted, and occasionally a true diabetes. Irregular fluctuations of temperature tending to normal yet often up one and two degrees, are common. There is often excitable or nervous irritability and sometimes altered disposition with mental depression and signs of mania.

It must be remembered that malignant goiter may at times present the most aggravated picture of Basedow's.

In the diagnosis of hyperthyroidism, Prof. Kocher regards leukœmia of the neutrophilic polymorphonuclears as an important early symptom, also a percentage and absolute increase in the lymphocytes. In over two hundred blood tests made upon patients with goiter, most of them with hyperthyroidism, we have at times found such changes marked, although some of the advanced cases varied greatly, sufficiently so to classify the condition in the same category with other laboratory tests. Fig. 5.

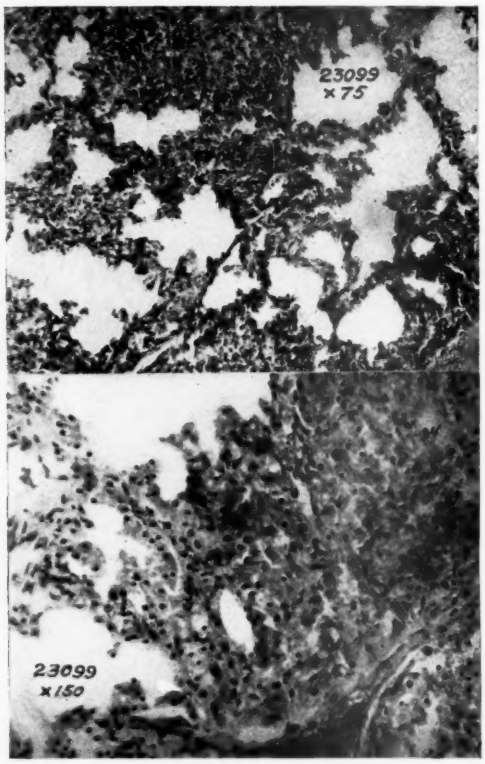

Fig. 8. Late degeneration in hyperthyroidism.

Notwithstanding the fact that many patients with the disease are cured spontaneously, and many are improved or cured by some type of medical, semimedical, or a form of serum treatment by cytolysis, the condition known as hyperthyroidism has stepped boldly into the field of surgery. It must be conceded that the operation is a serious one, that operating on those suffering from hypothyroidism because they still have some signs of Basedow's disease, will not benefit the patient, the surgeon, or surgery. Operations upon advanced cases of hyperthyroidism will not cure fatty degeneration of the heart muscle, nor fatty degeneration of the liver, nor advanced changes in other organs, although the disease may be checked by reducing the toxæmia. Altogether too much is expected especially from operations made under such conditions by those personally interested. The responsibility of the operator being great, the diagnosis of the condition, the accurate estimate of the stages of the disease, and the approximate condition of the gland and essential organs, must now be weighed with much more care than when the condition was considered purely medical and a death from it the "will of God."

The physician's judgment in his estimate of the patient's condition may lead him to first advise some form of non-surgical treatment, e. g., therapeutic, hygienic, etc. If improvement does not soon follow these measures, a surgeon should be called in consultation who may, from his standpoint, advise immediate operation or a continuation of, or additional treatment in the preparation of the patient for operation either upon the blood supply of the gland, or upon the gland itself at a later period. Fig. 8.

NON-PARASITIC CYSTS OF THE SPLEEN

By ROYALE HAMILTON FOWLER, M. D., Brooklyn, New York
Assistant Attending Surgeon, German Hospital

CYSTS of the spleen nay be divided into (1) echinococcus cysts, (2) dermoid cysts, (3) non-parasitic cysts. The first occur in regions where hydatid disease prevails and the spleen is rarely the only organ affected. They are the most common and the literature affords many references, according to Thomas[1] in two per cent of cases of hydatid disease. In forty-five cases it was the only seat of echinococcus cysts and in forty-three other cases collected by him other organs, in thirty-seven cases the liver, were also infected. There is but a single recorded case of a dermoid cyst reported by Andral[2] in 1830. Interest centers especially around non-parasitic cysts. They may be unilocular or multilocular and may be further classified according to their contents as hæmorrhagic, serous, and lymph cysts. Hæmorrhagic and lymph cysts may occur in neoplastic form as hemangioma and lymphangioma. The former tumor is rare while a blood cyst resulting from hæmorrhage into the parenchyma or just beneath the capsule is not so rare.

A case of multilocular cystic spleen has been observed by the writer, concerning the origin of which explanations offered in the literature do not seem entirely satisfactory. The patient, a woman 22 years of age, presented herself to Dr. B. F. Curtis with the following history: One year previous she fell backwards a distance of two and a half feet. She experienced localized pain upon exertion for a period of three months in the right hypochondrium which was relieved by an abdominal belt. She had not complained of pain for the last six months. Three months previously she was delivered of twins and since that time she complained of experiencing a sensation of something moving during sudden motion. A probable diagnosis of movable kidney was made and operation advised. A much enlarged spleen presented upon opening the abdomen. A leucocyte count was made while the patient was under ether and showed 22,000 leucocytes; differential count gave 59 per cent polynuclears, 41 per cent lymphocytes (large and small). She made an uneventful recovery. Following splenectomy the leucocytes were as follows: Two days after operation, 23,600; polynuclears 72½ per cent; lymphocytes 27½ per cent. Eight days after, 20,200 leucocytes, polynuclears 63 per cent; lymphocytes 37 per cent. Seventeen days after 18,900 leucocytes; polynuclears 74 per cent; lymphocytes 26 per cent. Twenty-eight days after operation 14,200 leucocytes; polynuclears 55 per cent; lymphocytes 41 per cent; eosinophiles 2½ per cent; basophiles 1½ per cent. The pathologic report is as follows: The gross specimen consists of an enlarged spleen 20 cm. in length. It is broadest at the poles where it measures 11 cm. The thickness at these points varies between 6 and 7 cm. The surface is lobulated especially at the poles and there are many small cysts projecting from the surface. At the center of the organ is a constriction separating the spleen into two quite distinct lobes. These are raised 2 or 3 cm. above the central constriction. The capsule stretches over the entire organ intact. The protuberances situated at the extremities are thin walled, project prominently outward and fluctuate. The larger is 7 cm. in diameter. Upon aspiration a fluid of yellow color, slightly turbid and of 1,030 specific gravity is obtained. The fluid showed 6 per cent albumin by weight, no reduction of Fehling's solution and microscopically many red blood cells The specimen was hardened in formalin and preserved in Kaiserling solution before longitudinal section was made The cut surface shows that the entire organ is cystic. The larger cysts are situated at the poles. The cysts contain whitish, homogeneous, semisolid masses, the result of coagulation by the fixative. When the jelly-like material is removed, the larger cysts are seen to be subdivided. The larger protuberance at the upper pole is seen to be composed of two large cysts. The smaller of these is smooth in its interior, the other has

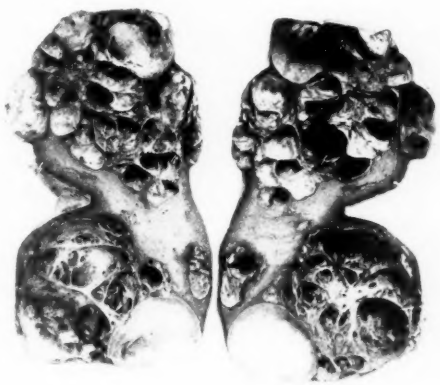

Fig. 1. Multiple cystic spleen.

[1] Thomas. Albbutt-Rolleston System of Medicine, vol. 4, part I, p. 456.

[2] Andral. Grundriss der pathologischen Anatomie, bd. 2, s. 257, 1830. Übersetzung von Becker. (Precis d'anat. path.)

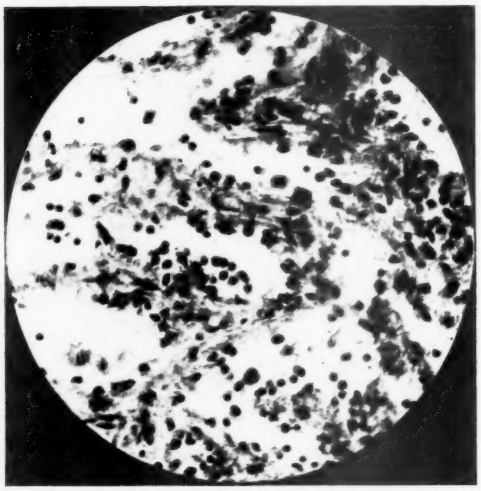

Fig. 2. Non-parasitic cysts of the spleen. Shows dilatation of lymph sinuses. Photomicrograph 500×. Slide No. 1.

many projecting edges or septa separating it into many small compartments, giving the appearance of the formation from the fusion of many smaller cysts. The other extremity is riddled with intercommunicating pockets of various sizes. There is an area of firm tissue fairly free from cysts in the region of the central constriction. The cyst wall is extremely thin in places and appears to be composed only of the serosa covering the organ. In the interior of the organ splenic tissue is seen to separate the cysts in some cases, while in others the lining membrane of the one appears to be in contact with another. The interior of the smaller cysts is for the most part smooth and glistening, and free from falciform projections. The weight of the organ exclusive of cystic contents is 385 grams. The vessels at the hilum do not appear thickened. There is no demonstrable lymphatic trunk.

Microscopic examination. The tissue removed was embedded in paraffin and stained with hæmatoxylin and eosin. Slide No. 1. This piece of tissue was removed from the region of the central constriction and shows no macroscopic cysts. The general appearance is that of a dilatation of the lymph sinuses. There are many spaces of various size and shape, some are tortuous and intercommunicating, others are long and arranged in parallel, some are round and others are oval. The entire section is seen to be made up of these spaces surrounded by splenic parenchyma. They possess a delicate membrane of connective tissue which composes the wall, supporting in some instances, endothelial cells. In other cases it is not possible to positively identify an endothelial lining. Lymphoid tissue is seen to touch directly upon the membrane in some cases. The contents show for the most part large and small mononuclear leucocytes, with a preponderance of the latter, shreds of fibrin, an occasional eosinophilic and neutrophilic leucocyte and here and there red blood cells. There are some scattered areas of round cells which appear to represent Malpighian bodies. These follicles show some hyperplasia, otherwise no change. The arterioles show normal walls. In some follicles they are situated eccentrically, others show two vessels peripherally located. The blood-vessels in other situations in this slide appear normal. The connective tissue trabeculæ are somewhat increased. In some situations they are seen to contain dilated spaces lined with endothelium and which contain lymphocytes and fibrin. These are taken to be dilated lymphatic vessels. Some of the larger spaces located in the parenchyma show in addition to the delicate membrane of connective tissue alluded to, a wall of connective tissue which appears thicker than that composing the wall of the smaller spaces. The wall is infiltrated with leucocytes and red blood cells. One or two of the larger spaces, in addition to the cellular contents, are partially occupied by homogeneous, pink staining masses. Slide No. 2. This was also removed from the region of the central constriction and shows macroscopic cysts half the size of a split pea. Microscopically there is less dilatation of the lymph sinuses and more actual cyst formation. The parenchyma is denser and shows a greater degree of congestion. The several large cysts visible to the naked eye appear under the microscope to possess a definite wall of connective tissue and in some instances an endothelial lining. They are occupied by a smooth, uniform, pink staining mass which has become slightly retracted from the walls. The cells lining these cavities have become separated in places, adhering to the homogeneous material. The walls of some of the larger cysts appear to be made up of connective tissue which has become changed through hyalin-like degeneration. It stains poorly a bluish color. These are to be considered secondary regressive changes. Scattered in and among the lymphocytes are deposits of finely grained blood pigment. The small dilated spaces which correspond to dilated lymph sinuses show cellular contents as described in the first slide and not coagulated masses of lymph. Some of the larger cysts are seen to be surrounded by more connective tissue which appears in elongate bundles and resembles obliquely cut trabeculæ. These are to be considered dilated lymphatic vessels lying in trabeculæ, they contain homogeneous pink staining masses, which in part have become retracted from the walls, the lining endothelium having become detached and adherent to the homogeneous material. Slide No. 3 shows a greater number of small cysts of variable size. Under the microscope countless cavities are seen, large and small, some are intercommunicating. In some instances they are separated by splenic tissue, in others the lining membrane of each serves to separate them. The majority are irregular in shape, some present finger-like projections or septa, giving the impression that they have been formed from the fusion of smaller ones. Separating the cysts in places are strands of connective

tissue, bluish staining fibers showing lymphocytic infiltration. The walls of the largest cysts show them to be composed of this same bluish staining tissue in addition to the lining endothelium. The walls are denuded of cells in places where they have become loosened and retracted with the homogeneous contents. Some cavities contain the homogeneous material, others this with lymphocytes scattered throughout. The contents of a few show red blood cells alone, others these with a narrow zone of homogenous material near the wall. The wall consists of a delicate connective tissue membrane in case of the smaller cysts, in part supporting endothelium. The connective tissue appears degenerated in places. The largest cysts show a thicker wall of connective tissue which has apparently undergone retrogressive changes. The thin membranes of the smaller cysts are in contact in places and show no splenic tissue between them. Slide No. 4. Sections were cut of the cyst wall of one of the larger cavities. In the gross the lining membranes of two cavities appeared to touch. Under the microscope the wall of each cyst appears to be formed of degenerated connective tissue. The tissue stains poorly a bluish tinge, the fibers seem more or less homogeneous and the nuclei are indistinct. There seems to be no endothelium, except in one place where the contents have become separated from the wall, retracting with it a few endothelial cells. There is deeply congested splenic parenchyma between the walls of the cysts. The lymphoid tissue is somewhat separated here, giving much the same appearance as that interpreted in Slide No. 1 as a general dilatation of the lymph sinuses. These are filled with coagulated masses of lymph and red blood cells. The blood-vessels in this situation appear normal. Slide No. 5. Sections were made at the hilum. The parenchyma here is occupied by a group of about a dozen cysts, they present the same features as hitherto described. In addition to these large cavities may be seen a dilatation of the lymph sinuses, this occupies the area immediately surrounding the cysts. There are two vessels, one is taken to be the splenic artery. It shows a much degenerated intima taking a bluish stain. There appears to have been some thickening. In some instances intima is absent. The internal elastic coat stands out distinctly. The degeneration seems to have invaded the media as shown by scattered areas of bluish staining tissue. The adventitia shows a similar degeneration, fibers and nuclei are indistinct. The lumen is occupied by coagulated masses and blood. It is not possible to identify the other structure. It is almost as large as the artery and is probably a vein. The wall, about half as thick as the artery, shows smooth muscle fibers and degenerated connective tissue. No intima or definite coats can be made out.

Pathogenesis. It is probable that many of the blood cysts so-called are subcapsular hæmatomas. Such cases usually present a history of trauma or an acute infection, although there is no definite relation to diseases causing splenic

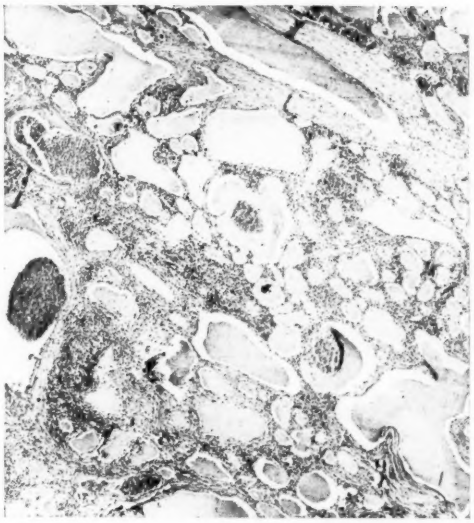

Fig. 3. Non-parasitic cysts of the spleen. Photomicrograph 75 ×. Slide No. 3.

enlargement. Serous cysts may form secondarily from hæmorrhagic cysts, the fluid constituents becoming clear by the deposit of solid material in laminæ upon the walls, on the other hand it is possible for blood cysts to form through the occurrence of hæmorrhage into the serous variety. Hæmorrhage may occur in the interior of the spleen and may be due to the rupture of an aneurysmal dilatation of an intrasplenic vessel with subsequent encapsulation of the extravasated blood. Harnett offers this explanation in a case observed by him in a man with a popliteal aneurysm, lues, and advanced arteriosclerosis, although there was an absence of marked disease in the spleen. Heinricius and others thus explain the occurrence of hæmorrhagic and serosanguinous cysts. Wm. H. Welch in studying a case of hæmorrhagic cyst reported by Geo. Ben. Johnson, suggested that an extravasation of blood of old date might be associated with infarction. Evidence of infarction would rarely be present. Böttcher considered that amyloid degeneration of the vessel walls causing occlusion, consequent necrosis of splenic tissue, and cyst formation was the cause of multiple serous cysts. The majority of blood cysts and degeneration cysts may be excluded from the list

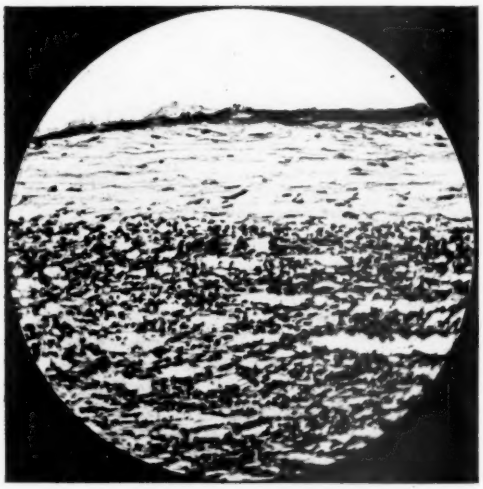

Fig. 4. Non-parasitic cysts of the spleen. Photomicrograph of cyst wall. 250 ×. Slide No. 4.

of genuine cysts of the spleen. The mode of origin of genuine cysts of the spleen may be explained in several ways. Such cysts may be considered (1) lymphangiomas; (2) as arising from snared-off peritoneal endothelium; (3) as arising from rupture of the splenic capsule with subsequent protrusion of the pulp and cyst formation. Fink was the first to recognize the true relation to the lymphatic system and described two cases. Renggli believes that in consequence of the fusion of proliferated areas on the surface, due to inflammatory processes, endothelium is snared off and in situations where such areas have been pressed deep into the splenic tissue is stimulated to energetic growth and cyst formation, the cyst coming to lie deep in the parenchyma. He considers that the single layer of cuboidal epithelium lining the cysts is the same as that which composes the peritoneum, except that the peritoneal endothelium of the surface has become flattened from the pressure of neighboring organs. He places the origin of these cysts at a time embryologically when the endothelium of the peritoneal cavity shows its original cuboidal characters. According to Otto such a cyst formation as Renggli describes should possess a flat layer of cells and should not be bordered on any side by splenic tissue. Ziegler in his text-book of pathology mentions the Renggli theory as a possibility but states that such cysts are rare. Kühne has dealt with the subject and reports three cases of splenic cysts. In investigating the cause he comes to the conclusion that the theory of Renggli is quite reasonable and holds good in one of his cases. The other two cases he considered lymphangiomas. Aschoff does not consider the form of the epithelial lining proof of its peritoneal origin as endothelium of lymph vessels could be transferred into cuboidal epithelium. He also considers their origin is to be found for the most part in the lymphatic system. It was claimed by Beneke[1] and his pupil Ramdhor, that cysts of the spleen originate from rupture of the splenic capsule, through which the splenic tissue protrudes. These so-called "hernias of splenic tissue" become snared off between neighboring areas of parenchyma, show tendencies of independent growth, and form cystic cavities. He considers the cells lining the cysts and the endothelium of the peritoneum identical. Schmidt[2] states that he has observed many cases and asserts that almost all small superficial cysts originate as tissue hernia following rupture of the splenic capsule. He also believes that certain cysts may originate from preformed canals of connective tissue. He leaves open the nature of these canals but believes they depend for the most part upon the lymphatic system.

Concerning the mode of origin of the case observed by me, I do not believe the theory of Beneke holds good. I am much more of the opinion that if rupture of the capsule did occur with subsequent "Milzgewebeshernien," the healing process would lead to cicatricial contraction rather than to cyst formation. In case of multiple cyst formation a large number of ruptures would necessarily have to take place and I do not believe that such extensive cyst formation could follow. I believe Renggli's theory equally unlikely in case of multiple cysts situated deep in the organ. It remains to assume that the writer has to deal with a new growth of the spleen and from a careful study of this case and others does not hesitate to for-

[1] Beneke. Über die entstehung der Milzcysten. 13 Internat. Kongres für Medizin. Paris, 1900, p. 317.

[2] Schmidt, M. B. Über Milzcysten u. Milzgewebeshernien. Virch. Arch., bd. 164. pp. 50–71 h. i. 1901.

ward the diagnosis of lymphangioma. In review, microscopically there is a general dilatation of the lymph sinuses and spaces are present in the trabeculæ indicative of lymphangiectasis. The small cysts show a thin membranous lining supporting endothelium, the larger in addition a thicker connective tissue wall, in places degenerated. The contents correspond to lymph. The red blood cells may be traced to secondary hæmorrhages. I believe the size of the tumor is against its originating from lymph stasis alone. The development of such tumors is sometimes traced to hypertrophy of the vessel wall which renders difficult the outflow of lymph and sometimes unknown causes lead to an increased supply of lymph. In explanation of the development the tumor may be considered as arising from misplaced embryonic cells. Ranvier and others have demonstrated in animals such snaring off or misplacement of lymph vessels in fœtal life. It is concluded that misplaced lymph vessels or their cells of origin if they are endowed with especially energetic powers of proliferation, may result in such an autonomous growth.

It remains for me to thank Dr. B. Farquhar Curtis for permission to report the case occurring in his service at St. Luke's Hospital. The writer gratefully acknowledges the aid which Dr. Francis Carter Wood has given in the preparation of this article. The photomicrographs are by Dr. Gardiner Hopkins and the photograph of the gross specimen by Mr. Simms of St. Luke's Hospital.

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VACCINE THERAPY AS AN ADJUNCT TO SURGERY[1]

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THE history of surgery has been largely that of a struggle to prevent or to relieve the consequences of infection. Only since the adoption of rational and purposeful methods of meeting this foe have surgical results attained anything like uniformity of success. Still infection remains our most alert and deadly enemy. Our patients often come to us overpowered with it and not infrequently it insinuates itself between us and success in spite of our best precautions.

Since the discoveries of Pasteur and Lister there has been nothing so widely heralded as an epoch-making advance in the control of infection as the method of vaccination advocated by Wright. With a view both to aid in the determination of the exact value of this form of treatment and to secure its benefits for our patients, there has been established at the German hospital a department of vaccine therapy under the direction of Drs. John C. DaCosta, Jr., and Damon B. Pfeiffer, to whom I acknowledge my indebtedness for their special knowledge which only has made this work possible, and also for several case reports which have been used in addition to those from the surgical department to reinforce the conclusions of this paper.

Such cases as furnuculosis, carbuncles of moderate size and other pustular affections of the skin, of which there has been a considerable number, I shall dismiss with a word. In these cases the action of the vaccines, which were always prepared from the micro-organisms isolated from the individual case, has been prompt and efficient, substantiating in every way the claims of Wright and others concerning their specific curative value. We believe it to be the treatment par excellence of obstinate infections of this nature.

In suppurating sinuses of the middle ear or mastoid the results have been almost, if not quite equally good. Such cases, while of less use to the general surgeon, serve to bolster a belief

[1] Read before the American Surgical Association, May 3, 1910.

in a specific curative action and to arouse hopes of similar efficiency in such cases as I am about to report, in which our need of assistance is greater. More detailed case reports will accompany the paper for perusal. At present I shall confine myself to the briefest note that will make the case intelligible.

We have employed vaccine in seventeen cases which were profoundly septic. In nine of these bacteræmia was demonstrated by blood culture. Among these there were three cases of streptococcic septicæmia of which we were not successful in saving one. The first case, No. 1, was moribund after six days of an overwhelming streptococcic infection originating on the right hand, resulting in a subpectoral abscess and extensive neighboring infiltration. Three incisions were made into the area of inflammation and, 24 hours before death, he was given 50,000,000 autogenous streptococci, which had no apparent effect. The vaccine in this case was a forlorn hope. It could not be expected that a patient, overwhelmed as he was, could summon reactive forces to any stimulation, nor was his death long enough deferred for the slowly forming opsonins to make their appearance in the blood.

Case 2 was one of endocarditis with multiple recurring streptococcic abscesses. This patient likewise had been abandoned as lost after a severe illness of seven weeks' duration. With the institution of vaccine treatment there was a very decided improvement so that hopes of his recovery were entertained. After gaining strength and weight for six weeks there was a sharp exacerbation of sepsis to which, in his exhausted state, he speedily succumbed.

Case 3 was a puerperal infection acquired as a result of packing the uterus to staunch a well nigh fatal late hæmorrhage after placenta prævia. In this case also vaccine treatment was not begun until after fifty days of the most severe and weakening sepsis. There was no amelioration of symptoms in this case, and death ensued three weeks later from general exhaustion with œdema of the lungs and suppression of urine.

These three cases give no basis for a hope that streptococcic bacteræmia is amenable to the vaccine treatment, though it may well be objected that these cases were either moribund or so far advanced in sepsis that no reaction could reasonably be expected. Early treatment may bring better results and in view of the desperate character of the disease, I would still be inclined to use the vaccines before organic deterioration had progressed to the stage of irreparable injury.

Our experience with staphylococcic bacteræmia has been more encouraging.

Case 4 was a young woman who had been suffering from symptoms of severe sepsis for seven weeks following a pelvic operation. A single large dose of staphylococcus aureus vaccine prepared from an organism found in the blood was followed by rapid defervescence and complete recovery.

Case 5 was also one of staphylococcus aureus bacteræmia following a nephrectomy for suppurative nephritis. Vaccine treatment was begun after three months of septic symptoms and was followed by recovery and healing of the sinus after one month's treatment.

Case 6, which was a case of Dr. James C. Wilson's, showed a staphylococcus aureus bacteræmia and a subperiosteal abscess of the skull due to the same organism. Evacuation of the abscess by Dr. Ross with autogenous vaccine treatment worked a rapid and striking cure.

Case 7 was clinically one of malignant endocarditis secondary to a pelvic abscess occurring after an abortion. Despite evacuation of the abscess by both vaginal and abdominal incisions the patient's condition was not relieved. Fever with chills, stupor, delirium, and the severest manifestations of sepsis were present. In the midst of this apparently hopeless condition four weeks after onset, vaccine treatment was begun, the organism being staphylococcus aureus which was recovered both from the discharging sinus and the blood. The first inoculation was followed by a severe reaction succeeded by improvement two days later.

After the second inoculation, five days later, the temperature fell to normal and remained so, the patient rapidly proceeding to complete recovery.

Case 8 was one of severe sepsis due to suppurative nephritis of hæmatogenous origin. After failure of a nephrotomy to relieve the condition and with the patient almost in extre-

mis a nephrectomy was done and followed by autogenous vaccine.

Recovery was rapidly effected.

Thus we have had five cases of severe staphylococcus bacteræmia with five recoveries.

Four of the cases showed the aureus variety, the remaining one yielding albus both from the blood and suppurating sinuses. Clinically four of the results appeared marvelous and recovery in each instance began with the administration of vaccines. The results of vaccines in staphylococcus bacteræmias are here seen to be as encouraging as they were discouraging in similar cases in which the infecting agent was the streptococcus, and while these cases are too few to dogmatize I shall in the future feel very remiss if I should neglect vaccine treatment in staphylococcus infections.

Case 9 was the only one of bacillary bacteræmia which we encountered. This was a case of puerperal sepsis following instrumental delivery. The organism, which was recovered twice from the blood, corresponded to the bacillus endocarditidis in morphology and cultural characters. Two small doses of an autogenous vaccine were given with no appreciable effect. Hysterectomy and bilateral salpingectomy were then done, but to no avail, the patient dying six days after the operation.

The next group comprises eight cases of severe septic infections in which the blood culture proved negative or was not taken. It is probable that several of these cases were also bacteræmias.

Five of these cases were instances of streptococcic infections, the first three beginning on the hand and rapidly traveling upwards with symptoms of great systemic intoxication. Two of these cases, No. 10 and No. 11, rapidly passed out of danger after inoculation of vaccine, which was begun early with the patient in comparatively good condition. The third case, No. 12, was in a low muttering delirium when first seen, was given only one small dose of stock vaccine and died the third day following without rallying to any extent, though on the day after admission he appeared better and was rational for a time. This may have been due also to the free incisions made at the time the vaccine was administered.

Case 13 was one of streptococcic pyæmia with multiple abscesses and resulted in recovery after a somewhat desultory use of autogenous vaccine combined with evacuation of the abscesses as they appeared.

Case 14 died in three days after the onset of an acute streptococcic peritonitis, no improvement being manifest from vaccines or antistreptococcic serum.

Case 15 was an instance of sinus following evacuation of an appendical abscess with a febrile convalescence complicated by bilateral parotitis. A vaccine of staphylococcus albus prepared from sinus pus was used. The result was satisfactory though the influence of the vaccine in this case was not clear.

Case 16 had a large abscess of the thigh secondary to spontaneous suppurating thrombus of the internal saphenous vein. The vaccine of staphylococcus albus was used in this case to hasten the cleaning and healing of the large abscess cavity, which effect seemed to be hastened by it.

Case 17 was an instance of suppurative nephritis treated by nephrotomy and vaccines without benefit to the septic condition. Nephrectomy was therefore done fifteen days later and followed up by the vaccine treatment. The organism in this case was the staphylococcus aureus derived from the discharge. The septic symptoms were not abated by the inoculations and death followed five weeks after operation.

Of the streptococcic infections in this group three recovered and two died. The recoveries were in cases of the most desperate character while one of the deaths occurred in a case of fulminating peritonitis and the other in an old man who was moribund when first seen.

The remaining three cases had staphylococcus infections. Two infected with the albus variety recovered. One who had suffered a nephrotomy and then a nephrectomy failed to respond to inoculation of aureus vaccine. Unfortunately the site and extent of the septic process was not determined by autopsy.

In addition to these more serious cases showing symptoms of systemic sepsis I have employed vaccine in a number of cases of localized foci of infection or suppuration with a view to hastening the healing of the process. Indo-

lent abscess cavities and persistent sinuses from various conditions may be stimulated to increased granulation and more rapid closure. Thus in one of my cases, No. 18, a persistent sinus down to the pelvis remained for one month after an operation in which it was necessary to leave tubular drainage down to the cul-de-sac. One inoculation of a vaccine prepared from the organism isolated from the discharge produced a sharp general reaction with a local erythema and tenderness about the opening of the sinus. A second inoculation was given and the sinus was closed completely and without further complication one week after the first infection.

As a rule the reaction is not so prompt and conclusive as in the cases just quoted, but I am convinced that I have frequently seen unmistakable evidences of improvement which could be traced directly to the influence of the inoculations. In no case has there been any harmful effect so far as could be observed.

This form of treatment is not designed to supplant any of the well tried and effective means of overcoming infection. Its adoption will not stay the surgeon's hand nor relieve him of his responsibility. It is merely an adjunct and may be employed in any suitable case without incompatibility to any other measures. If it be employed as a panacea it will bring disappointment, but properly used, it will in a series of cases have a favorable effect on morbidity, and I believe on mortality as well. It is one of the aids which a man energetic in the interests of his patients will not neglect.

For its employment a competent bacteriologist and one skilled in laboratory procedures must be available. Stock vaccines are to be used only as a makeshift and in an emergency. The specificity of the bodily reaction renders autogenous vaccines necessary for the best results.

It must be remembered that a vaccine depends for its action not upon any direct antitoxic or antibacterial substances but acts only secondarily by inciting the production of these substances by the patient himself. This fact explains at once why no effect is to be expected in one already overwhelmed with infection, and makes it necessary both to use a smaller dose in proportion as the patient is more toxic and to wait until reaction is established before giving the next dose. The best rule is this: the sicker the patient and the less satisfactory the reaction, the smaller and less frequent should be the dose. It is well to observe that this is the exact opposite to that which holds good for the antitoxic serums.

The more vigorous the subject, the less his powers of reaction have been sapped by disease, in other words the earlier the treatment is begun the greater should be the chances for success. This should seem a corollary to the surgeon's mind, impressed as he is continually with the disastrous effects of delay.

The method of preparation of the vaccines used in this series has been that formulated by Wright. In every instance, except one in which there was not sufficient time to isolate the organism, the vaccine has been made from a growth derived from the individual case.

The dosage has varied from 25,000,000 in the case of streptococcus infections to 750,000,000 in one case of staphylococcus aureus bacteræmia. The average dose has been about 100,000,000. This is a smaller quantity than has been advocated by many. We have been influenced to make our dose small because we have not infrequently observed definite reactions after injection of this amount and believe it to be best to adhere to the advice of Wright to use the smallest dose that will produce a reaction. We are not unmindful also of the disastrous effects that followed the early use of tuberculin in doses which seemed at first infinitesimal but are now known to have been a thousand times too large. Our guide in administration has been the clinical one. The experience of the vaccine department in the control of such cases by means of the opsonic index has been disappointing, as in the hands of most other observers. Careful observation is the best indication both for the necessity and results of vaccine administration.

The interval between doses has varied from one day to a week or more, the average being five to six days. In only a few instances have we tried the daily use of a vaccine and in no case has it been followed by improvement, thus bearing out the theoretical objection against such use. It is safer to make the in-

terval too long rather than too short. A patient restraint therefore should be exercised in the employment of this remedy, for harm can come only by too frequent or too large doses.

As a contraindication to vaccine treatment conducted in this manner we can mention only one, namely, overwhelming sepsis. It is not rational to expect help in such a condition and from the nature of the case it is possible to do harm by adding more toxin, though we have not seen an instance of this clinically.

The general indication for its employment is chronic or subacute infection or acute infection with good resistance, the dosage to be regulated by the severity of the infection and the known virulence of the organism and its toxins.

To recapitulate: Specific vaccine treatment in our hands has not proved of benefit in the later stages of streptococcic septicæmia.

Staphylococcic septicæmia has been treated with most favorable results in all stages.

Septic intoxications without demonstrated blood invasion in a majority of the cases display general and local improvement under the use of vaccines if given early; the later the treatment the less certain and satisfactory the result.

Localized and persistent suppurating conditions are sometimes markedly benefited by vaccines.

Surgical procedures for the relief of infectious conditions should be reinforced by vaccine treatment, which should be begun as early as is consistent with the case, and preferably by autogenous organisms.

No hospital can be considered fully equipped which is not prepared to supply this form of treatment in conjunction with established measures.

CASE REPORTS

CASE 1. *Streptococcus bacteræmia.* Mr. S. A man of 50 years, affected with sepsis consequent to infected wound of right hand, with intense cellulitis of arm and large subpectoral abscess of corresponding side. Six days after the latter focus had been incised and drained, the patient suddenly became alarmingly septic, whereupon he was given an autogenous vaccine (derived from a positive blood culture) of 50,000,000 streptococci. But this single injection in no way modified the clinical picture, and death ensued, after twenty-four hours of increasing toxæmia and symptoms of profound septic intoxication.

CASE 2. *Streptococcus bacteræmia.* Mr. P. Malignant endocarditis and multiple abscesses secondary to tonsillitis in a man 29 years of age. Patient referred to vaccine department by Dr. Stahl. Illness of 117 days' duration, characterized by septic fever; recurrent sweats and chills; progressive emaciation and asthenia; high-grade anæmia; and cardiac signs consisting of double aortic and mitral systolic murmurs (changeable), left ventricular dilatation, and extreme arrhythmia. Leucocytes did not exceed the maximum normal limit, and the urine was negative. The purulent lesions implicated the right hand, wrist, and ankle, the left forearm, both elbows, and both legs, most of the foregoing foci having been incised and drained, without any lasting relief whatever.

During a period of 34 days this patient received fifteen inoculations of streptococcus autovaccine, made from a blood culture, the doses ranging individually from 25,000,000 to 50,000,000 bacteria and totaling 550,000,000. No post-inoculative reactions occurred, nor had the treatment the slightest permanent benefit. Five of the injections seemed to ameliorate the local and systemic symptoms, and to produce a transient reduction of the temperature to normal — for as long as 14 days on one of these occasions; eight were succeeded by increased fever; and after two no appreciable change was apparent. Ultimately the patient died, after a preagonal week of high intermittent fever, severe rigors, profuse sweats, and exhausting septic intoxication.

CASE 3. *Puerperal septicæmia.* Streptococcic vaccine treatment begun on 50th day; unimproved; death in 23 days.

Mrs. H. S., aged 37, was admitted December 29, 1909, to the Woman's Maternity Hospital in the service of Dr. Tallant, by whom she was referred to the vaccine department. She was bleeding profusely when admitted, as a result of placenta prævia. Pregnancy was seven and a half months advanced. Dilatation, internal version, and extraction was performed. A profuse and nearly fatal hæmorrhage occurred five hours later. Puerperium was normal until the 8th day when another alarming hæmorrhage took place and it became necessary to pack the uterus. In two days the temperature rose and the further course of the case was that of profound sepsis with thrombosis of pelvic veins, endocarditis, and multiple arthritis. Streptococci were found in the blood culture and vaccine treatment was begun 50 days after onset.

The dosage varied from 10,000,000 to 100,000,000 and the interval from one to seven days. The condition seemed to be aggravated at first, then improved, but there was no constant relation nor definitely observed effect of inoculations. Patient succumbed 23 days later with œdema of lungs and suppression of urine.

CASE 4. *Staphylococcus bacteræmia.* Post-operative sepsis in a single woman of 29, the symptoms being of four weeks' duration and having developed three weeks after an ovarian resection. Hyperpyrexia; drenching sweats; irregular chills; 30 pounds' loss of weight; painful, enlarged spleen; prostration; intense anæmia; leucopœnia of 4,900; toxic albuminuria.

The patient was given a single inoculation of 750,000,000 cocci prepared from staphylococcus aureus found by blood culture; no noteworthy post-inoculative symptoms. The temperature began to subside at once and eight days later had reached normal and remained so; the sweating and rigors had ceased; and the progressive improvement led to uneventful recovery, the patient being discharged, well, 19 days afterwards.

CASE 5. *Staphylococcus bacteræmia.* Post-operative sepsis in a married woman of 22 years, due to hæmatogenous infection of the kidney with resultant subcapsular abscess which had been draining externally through a sinus persisting for three months after incision of the abscess. Characteristic septic temperature; moderate sweating; emaciation; anæmia; and other objective signs of septic absorption; leucocytosis of 16,000; toxic albuminuria and granular casts.

This patient received six injections, 100,000,000 each, of staphylococcus aureus vaccine, made from a post-operative blood culture, two weeks elapsing between the first two inoculations and four-day intervals between the four subsequent ones. The first injection only was followed by a reaction; pyrexia of 102.5° F. After thirty days' treatment the patient's septic symptoms quite disappeared, and she was discharged at the end of this period, symptomless, and with sinus dry, painless, and granulating healthily.

CASE 6. *Subperiosteal abscess.* Bacteræmia; treatment by incision and drainage and autogenous vaccines; rapid improvement, disappearance of bacteræmia.

Mr. C., aged 50 years. Admitted December 14, 1909, with painful, fluctuating swelling over left ear. Four months before he had had a succession of boils; two weeks after their appearance he had been confined to his bed where he remained about five weeks, with a diagnosis of typhoid fever. In November he returned to work, but a few days later began to have pain over the left ear and gradually an abscess formed in this location. The abscess was incised and from the pus staphylococcus aureus was recovered in pure culture. The blood culture revealed the same organism. Vaccine was made from the organism recovered from the abscess and three doses of 50,- 100,- and 150,000,000 given at intervals of five days. Discharge from the abscess became noticeably thinner and clear and the general condition improved greatly. He was discharged to await the formation of a sequestrum, the exposed bone of the skull being denuded and dead.

Was readmitted February 3, 1910, when the dead bone was removed at operation by Dr. Ross. Three inoculations of 150,000,000 each of vaccine were given and he returned home in better health than for years.

CASE 7. *Staphylococcus bacteræmia.* Malignant endocarditis secondary to pelvic abscess, occurring in a woman of 32 years, six days after an abortion at the fifth month of pregnancy. Hyperpyrexia; sweating; chills; prostration; stupor; low delirium; changeable systolic apical murmur; arrhythmia; cough; purulent sputum; disseminated pulmonary crepitations. Pelvic pus had been scantily draining from a vaginal incision for four weeks, and from an opening in the left groin for three weeks, despite which operative steps the patient was desperately septic and virtually moribund. Staphylococcus albus was recovered from the pelvic sinus and from a blood culture.

To this patient was administered two injections of staphylococcus albus autovaccine, grown from a blood culture, the first inoculation (50,000,000 bacteria) being immediately followed by a violent chill, aggravated delirium, and a rise of fever amounting to 1 4-5° F. Two days later the subject's general condition was perceptibly improved, her mind was perfectly clear, and the pelvic mass was smaller. The second inoculation (100,000,000 bacteria) was given five days subsequently, after which the temperature fell to normal and remained so, the pelvic mass practically melted away, and the case went on to uninterrupted recovery within the succeeding sixteen days, when she was discharged well.

CASE 8. *Staphylococcic toxæmia.* Mrs. E. Sepsis incident to suppurative nephritis of hæmatogenous origin, in a married woman of 24 years, ill for three weeks with symptoms consisting chiefly of temperature disturbances and rigors, vomiting, constipation, and toxic depression, together with local signs of abdominal rigidity, pain, and distension, and a hard, tender, right loin tumor. Blood cultures negative; leucocytosis of 24,800; marked toxic nephritis. After a fortnight of active illness the right kidney was exposed, and 1 cc. of pure staphylococcus aureus pus aspirated from a soft area on the renal surface; free incision of the organ failed to reveal further suppuration, and the operation was followed by a deepening of the already grave sepsis and by rapid failure of the patient's strength. Nephrectomy therefore was performed.

Autogenous vaccine treatment begun on the first day after operation, dose 50,000,000, repeated on third day and on following two days. Temperature came down almost to normal, then gradually rose again to 104° F. Vaccine treatment administered again on the 30th day, dose 100,000 000; repeated on the following day and two days after that and then every four days up to the 26th day (same dose). Temperature normal on the 29th day and remained so until the 43d day when it shot up. 200,000,000 dose injected and repeated every fifth day. Temperature came gradually to normal and so remained.

Patient discharged feeling well, gaining in weight and strength.

CASE 9. *Puerperal septicæmia.* Supravaginal hysterectomy. Bilateral salpingo-oöphorectomy. Two inoculations of autogenous vaccine before operation. Death.

M. B., aged 19 years. Three weeks before admission patient had been delivered instrumentally. Three days later signs of infection developed with fever, chills, sweats, and headache.

January 5th, curetted by doctor, followed by slight improvement.

On admission, January 12, 1910, she was septic, showed a soft systolic murmur at the cardiac apex, but otherwise nothing.

Vaginal examination showed nothing significant. Patient steadily lost ground and a vaccine was eventually made from the bacilli recovered on two separate

occasions from the blood, which corresponded to the B. endocarditidis, of which two doses were given, six and nine days after admission respectively, of 30,000,000 each. There was no effect on the symptoms or temperature.

Operation was performed on the day following the last injection. There was no improvement, and the patient died of sepsis on the sixth day after operation.

CASE 10. *Streptococcic toxæmia.* Mr. S., a man of 54 years suffering from septic intoxication with streptococcus cellulitis of left arm secondary to infected wound of left hand. Illness of five days with fever, chills, and other signs of well developed septic poisoning; affected arm hugely swollen, red, boggy, and covered with vesicles, which condition became aggravated despite the evacuation of pus by multiple incisions and by through-and through-drainage with continuous bichloride irrigation. Blood culture sterile; leucocytosis of 25,500; urine febrile.

An initial dose of 25,000,000 stock streptococci was given the day after drainage was established, and within twenty-four hours slight, though real, improvement in the patient's general condition was apparent. Three days later, the improvement still continuing, a second inoculation of autogenous bacteria (30,000,000) was given, and from this time onward both the local and the toxic phenomena steadily diminished, until perfect recovery was attained, within a fortnight.

CASE 11. *Streptococcic toxæmia.* Mrs. D., a married woman, 53 years old, with moderate septic intoxication and purulent cellulitis arising twenty-four hours after having received an infected wound of the left little finger. Nausea, chills; hyperpyrexia; leucocytosis and albuminous urine. Lymphangitis of left forearm; painful inflammatory swelling and induration of infected finger and hand. Slight improvement of the local lesion and a temporary fall of temperature followed the use of the knife, and later the wound discharged pus, which the incision failed to disclose; nor did two larger incisions afford anything more than a transient amelioration of the local signs.

Within a period of 23 days this patient received 195,000,000 streptococci, derived from a culture of the arm lesion, the injections having been made at intervals of four, seven, seven, and five days respectively. Four days after the second inoculation the symptoms became purely local, and after the third both the cellulitis and the suppuration became strikingly less. Vaccine treatment was not employed during the healing of the persisting sinuses, which required three months for complete healing.

CASE 12. *Streptococcic toxæmia.* H. R., aged 63.

Five days previously the left hand began to swell rapidly, the inflammation beginning in a neglected cut on the dorsum. When seen the hand and arm were enormously swollen and inflamed. The patient was profoundly septic and in a low muttering delirium. The pus from incision on the dorsum showed streptococci. Free incisions were made in the hand and arm and 25,000,000 streptococci given subcutaneously from a stock vaccine. The following morning there was some general improvement which however was not maintained, the patient dying three days later.

CASE 13. *Streptococcic toxæmia.* Mr. W. Septic intoxication due to streptococcus cellulitis and multiple abscesses of left thigh, wrist, and elbow, in a man 48 years of age. The former was riddled with abscesses and deeply infiltrated with pus; the latter was the seat of a post-operative sinus which had discharged a thin serosanguinous fluid for several weeks. Constitutional symptoms, of five weeks' duration, consisting chiefly of progressive æsthenia and headache; irregular vomiting and diarrhœa; fever and sweating; and intense pain in the affected parts. Blood cultures sterile; leucocytosis of 21,000; febrile albuminuria.

The subject received, at approximately weekly intervals, four inoculations of streptococcus vaccine, prepared from a culture of the elbow pus, which yielded a pure growth of streptococcus pyogenes. The first inoculation (25,000,000) produced neither reaction nor improvement. The second inoculation (50,000,000) was given directly after 900 cc. of pus had been removed, by incision and drainage, from the thigh, the patient at this time being critically toxic and all but pulseless. The following day improvement was obvious, and within twelve days (during which time two more inoculations of 50,000,000 bacteria each were given) all systemic symptoms had disappeared, and the operation wounds were free of pus and granulating normally. Perfect recovery subsequently took place.

CASE 14. *Streptococcic toxæmia.* Mrs. A. Intense sepsis with purulent peritonitis secondary to abscess of the right broad ligament. A married woman of 20 years, with acute peritonitis and grave toxæmia of about five days' duration, for three weeks previous to which a painful pelvic mass and a profuse seropurulent vaginal discharge had existed together with high intermittent fever, recurrent chills, prostration, and similar significant symptoms On the eighteenth day a quantity of thick, yellow pus was evacuated by vaginal puncture, and a few hours later, after the onset of a clinical picture of internal hæmorrhage, the abdomen was opened, revealing a small quantity of pus and a diffuse general peritonitis, from which death occurred three days later. Blood cultures in this case were sterile, but the pelvic pus swarmed with streptococci.

Daily inoculations, totaling 175,000,000 bacteria, of stock streptococcus vaccine were employed in this instance during the three days elapsing between the operation and the subject's death, and in addition 80 cc. of antistreptococcus serum were given. Stock vaccine was resorted to because of the very slow and scanty growth of the streptococci sown from the patient's pelvic pus, by fault of which autogenous vaccine was unavailable.

CASE 15. *Periappendicular abscess.* Incision and drainage; symptoms of sepsis with bilateral parotitis during convalescence; autogenous vaccine; progressive recovery.

Mrs. J. B., aged 36 years. Admitted January 27, 1910. Suffering from periappendicular abscess. Attack began two weeks previously. Two days after admission, abscess was drained by loin incision, but

the appendix was not removed. Culture from the pus showed bacillus coli. Recovery was proceeding uneventfully when ten days after operation the temperature suddenly rose and assumed a septic character. Coincidentally she developed a bilateral parotitis.

Culture from the discharging sinus showed a staphylococcus albus from which vaccine was prepared and given in doses of 50,000,000 daily for four days. Temperature fell progressively and general symptoms improved; thereafter vaccine was given at intervals of four days in doses of 50,000,000 for one month when she was discharged well.

CASE 16. *Thrombophlebitis of the left internal saphenous vein.* Abscess formation; incision and drainage;. general septic symptoms. Vaccine treatment; recovery.

Mr. I. Z., aged 43 years, was admitted March 1, 1910, having been suffering for two weeks with inflammation, pain, and swelling of right thigh along course of the internal saphenous vein. He had had varicose veins since childhood and phlebitis one year previously. A large abscess was found in the mid-thigh and incised. He was improving satisfactorily when suddenly one week later symptoms of sepsis supervened.

The abscess cavity was again thoroughly explored and a vaccine made from the discharge which yielded staphylococcus albus. He received in all eight doses in quantities varying from 100,000,000 to 150,000,000 at intervals varying from 4 to 8 days. Improvement was gradual but progressive, and complete in six weeks.

CASE 17. *Intermittent pyonephrosis; sepsis following nephrotomy.* Vaccine treatment begun in extremis. Death.

Mrs B., aged 41 years. Admitted January 11, 1910. For the past six years the patient had experienced intermittent attacks of pain in the right lumbar region and hypochondrium with nausea and vomiting. At such times a tumor could be felt in the hypochondrium. As the attack passed off the tumor also would disappear with the passage of a considerable amount of cloudy urine. Last attack was three days before admission. An enlarged and tender kidney could be felt in the right hypochondrium. At the right apex posteriorly an occasional dry râle could be heard, otherwise examination was negative.

Operation. January 13, 1910. Nephrotomy. Following operation the temperature ranged high, the patient vomited frequently and appeared to be septic. The urinary fistula drained profusely. As she was evidently failing it was decided to remove the kidney, which was done on February 12, 1910. The general condition did not improve. A blood culture showed staphylococcus albus (?) from which a vaccine was prepared and three doses of 100,000,000 each given on successive days, beginning the ninth day after operation.

Patient was in extremis and died on the third day after beginning vaccine.

CASE 18. *Abdominal sinus persisting one month after operation.* Two inoculations with autogenous vaccine. Closure in one week.

Mrs. W., aged 36 years. Was operated upon for chronic salpingitis and chronic appendicitis, April 24, 1909. It was necessary to leave tubular drainage down to the pelvis at the time of operation. Patient did well but the sinus persisted along the tract of the drainage tube. Culture taken from the sinus showed unidentified Gram positive bacilli, from which vaccine was made. On May 20th an inoculation of 100,000,000 bacteria caused a sharp general reaction with headache, backache, abdominal pain, rise in temperature to 102.° May 24th, dose repeated with slighter reaction. Four days later the sinus had completely closed.

CASE 19. *Pelvic abscess and cellulitis following abortion; vaginal puncture.* Recovery with indurated mass in pelvis which melted away rapidly under autogenous vaccine treatment.

Mrs. A. T., aged 23 years. Admitted March 15, 1910, with large, indurated, tender abscess behind and to the left of the uterus, which had followed an abortion and curettement two weeks previously. The abscess was evacuated by vaginal incision and staphylococcus aureus found in the pus. Recovery proceeded satisfactorily. Second examination made nine days later showed a mass in the right fornix. Vaccine was made and four doses of 200,000,000 each given at intervals of three and five days. General condition improved and vaginal examination two weeks after beginning the vaccine showed practical dissipation of the pelvic mass.

CASE 20. *Thoracic sinus following drainage of empyema persisting three and one-half months.* Complete closure in one and one-half months under vaccine treatment.

Miss J. K., aged 19 years. Admitted July 28, 1909. Suffering with a right sided empyema of unknown duration. For several months she had had a productive cough and more recently had had night sweats and some bloody expectoration. Sharp pain in chest began ten days previously.

No tubercle bacilli were found in the sputum.

On July 31, 1909, the pus was evacuated by resection of a portion of the 9th rib. The patient was discharged with a sinus and referred to the dispensary for treatment. On November 10, 1909, the sinus was still open and discharging thick yellowish pus, which showed on culture an unidentified bacillus from which a vaccine was made.

Inoculation of 25,000,000 was followed by local pain in the region of the sinus.

November 14, 1909, 100,000,000 gave a general reaction with pain in the back and headache.

November 19, 1909, 100,000,000 inoculation. The discharge had become more fluid.

November 28, 1909, 100,000,000. Discharge diminished.

The vaccine was continued every seven days until December 31, 1909, when the sinus was completely closed.

CASE 21. *Suppurative arthritis of knee; spontaneous rupture.* Vaccine treatment without effect. Amputation. Infection of stump treated by vaccine. Recovery

Mr. M. D., aged 55 years. Admitted December 29, 1909. Six weeks before admission the left knee became swollen and very painful. Five weeks later the abscess broke through the popliteal space. On admission the sinus was discharging freely and a probe could be inserted down the midline of the calf about five inches and up under the fascia lata. Staphylococcus albus was obtained from the pus and it was sought to save the knee by free incision and drainage supplemented by vaccine treatment. He was given 5 doses averaging 90,000,000 at intervals of four to six days. Symptoms of sepsis persisted and the bones of the knee were becoming more disorganized. Amputation was therefore done. The wound broke down and from the discharge staphylococcus aureus and an unidentified baccillus were recovered from which a mixed vaccine was made. This was not employed until two months after operation. Healing has been very slow. Clinically it appeared to be hastened by the vaccine employed.

CASE 22. *Staphylococcic cellulitis of knee.* Incision. Vaccine treatment. Rapid recovery.

Mr. H. B., aged 45 years, was admitted with a huge brawny swelling about the left knee which had started three days previously from a pimple over the patella. The temperature was 102° and the symptoms those of mild sepsis. An incision was made through the pustule from which staphylococcus aureus was recovered. The temperature began to fall. An injection of 100,000,000 bacteria the next day was followed by a slight febrile reaction and a decline to normal the day following. Subsidence of the process was rapid, the vaccine being continued at four-day intervals for three doses, when recovery was complete.

FURTHER EXPERIMENTAL DATA ON THE VASOMOTOR RELATIONS OF SHOCK

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A CORRECT theory of shock, based on however careful experimentation, cannot be developed without considering in a priori fashion, certain accepted facts. Failure to handle the subject in this manner, accounts in large measure for the wide diversity of opinion that prevails to-day, as well as for the marked degree of uncertainty and hesitancy that characterizes our knowledge of this subject. A theory to be satisfactory, even as a working basis, must dovetail properly with definitely known clinical phenomena, with recognized physiological laws, and with basic biological principles.

To just what degree a theory falls short, as the result of failure to deal with the problem from this point of view, we can best illustrate by a concrete example: It is safe to state that the most generally accepted doctrine of shock to-day, is the one first enunciated in the early sixties by Mitchell, Keen, and Morehouse and cleverly elaborated during the past few years by Crile's experimentation. This doctrine states that shock is due to vasomotor exhaustion and consequent paralysis and dilatation of the peripheral vascular system. The clinical phenomena that almost constantly accompany shock may be grouped under the heads of: anæmic, almost bloodless body surface, lowered surface temperature, small pulse, feeble heart action, and mental torpor. Of these phenomena, the anæmia of the body surface, the lowered surface temperature, and the small pulse (all cardinal symptoms) do not tally with the assumption that the peripheral vessels are paralytic and dilated. Here then is the first failure of the supporters of the theory to correlate seemingly divergent facts. The theory assumes, moreover, that a most important portion of the nervous mechanism of the body is exhausted. It has been definitely settled for us by physiologists,[1] however, that the peripheral nervous mechanism most positively cannot be exhausted or even fatigued artificially, and that in all probability the important centers of the central nervous mechanism are also indefatigable. Here then is a second failure to correlate facts, and a second added weakness in the theory. Finally the theory assumes that the vasomotor centers are poorly armed for defense, and that they therefore are the first to break ranks under the onslaught of traumata. This assumption is

[1] "Fatigue": Frederic S. Lee, Harvey Lectures, 1905–6, p. 169.

directly counter to a general law of biology, which teaches that the so-called fundamental functions (under which head vasomotor control is classified) were evolved countless ages of time prior to the accessory functions (skilled movements, special senses, etc.). Furthermore, the earlier evolved functions are but slightly affected by the impact of afferent impulses as contrasted with the accessory functions, which, lacking "the poise of countless generations, cannot so readily defend themselves against the afferent stream."[1] The theory, therefore, fails to correlate itslef with a fundamental law of biology. Failure to substantiate clinical, physiological, and biological principles, to say the least, suggests some inherent weakness in the theory.

In a previous paper [2] we attacked the widely spread doctrine that shock was due to exhaustion of the vasomotor centers and consequent paralysis of the peripheral vascular system. We rested our case on definite experimental data to prove that the peripheral vascular system was *not* paralyzed. The present paper is a continuation of the work already reported. Here, as in our previous work, we are forced to express our idea of shock in terms of blood pressure, for the reason that no other factor in the symptom complex permits of such constant and accurate measurement. And here, as also in our last paper, our object is to correct error rather than to frame a new theory. Our previous experiments were confirmed, and numerous details were added (such as the freezing and cocainization of nerves before division, and curarization of the animals) in order to make results doubly certain.

A large part of our later experiments were based on the fact that stimulation of the central end of a cut vagus, when the other vagus is also divided gives a remarkably constant pressor effect. Exposure of the nerve, chilling or drying of it, and the traumata resulting from the necessarily frequent stimulations in no way interfered with an immediate and fairly constant rise of blood pressure after every stimulation. Furthermore, stimulation of the central end of the vagus did not give rise to any paroxysms of pain, such as we encountered previously in stimulating the central end of various other afferent nerves in animals deeply anæsthetized. These paroxysms of pain when they occurred markedly interfered with us, in our earlier work, in that the violent respiratory reflexes and muscular contractions set up by the pain rendered the correct interpretation of manometric tracings very difficult.

The constant pressor result, following stimulation of the central end of the vagus, seems to be an exception to the phenomena worked out by Hunt[3] who showed that the stimulation of afferent nerves may result in a pressor or a depressor effect, according to varying conditions.[4] At all events, this particular method of stimulating the central end of the vagus afforded an excellent opportunity for studying the so-called percentile rise of blood pressure. It is well known that stimulation of an afferent nerve, under suitable conditions, causes a rise of blood pressure. With the circulatory mechanism in a constant state of equilibrium (if such a condition may be assumed, for argument's sake) a constant stimulus ought to be followed by a constant definite rise in pressure. If, on the other hand, the blood pressure of the animal experimented upon is, for any reason, and with any degree of permanency reduced, the rise of a pressure following stimulation of an afferent nerve could not be expected to reach the height attained during the stage of normal blood pressure. Under such circumstances, stimulation will be followed by a rise of pressure, but the height of the crest of the rise from the abscissa line is less than that of the crest of the rise when the stimulus was applied during a stage of normal blood pressure. In other words, the absolute rise in pressure, consequent upon stimulation, depends very largely upon the height of the blood pressure at the time of the stimulation. If the pressure is high when the stimulation is made, the consequent rise will be sharp and marked, whereas, if the pressure is low at the time of stimulation, the rise will be much less marked. The percentile rise, as understood by Porter (l. c.),

[1] Vasomotor Relations: W. T. Porter, Harvey Lectures, 1906–7, p 98.

[2] The Condition of the Peripheral Blood Vessels in Shock. Journ. A. M. A., Jan. 2, 1909, p. 45.

[3] R. Hunt. Jour. of Phys., 1895, p. 381.

[4] The constancy of the pressor response to stimulation of the central end of the cut vagus, when the other vagus is divided, is the subject of another research, being carried on at the present time.

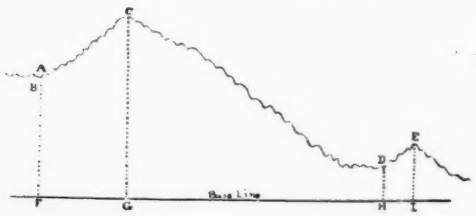


Fig. 1. To illustrate percentile rise in pressure.

and as used by us, refers to the relationship between the height of pressures before and after stimulation, rather than to the actual height of pressure. A diagrammatic blood pressure tracing will serve better than words to illustrate the problem of absolute and percentile rises in pressure. See Fig. 1.

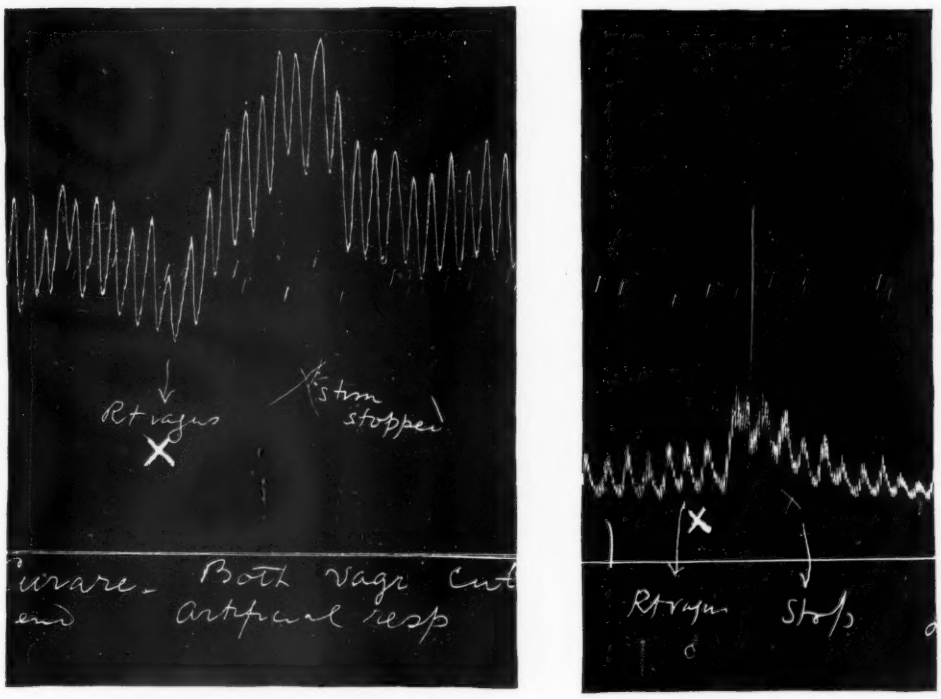
A F represents, let us say, a normal blood pressure of 130 mm. of mercury. At B, an afferent nerve is stimulated electrically, and immediately the blood pressure rises to a height C G. As a result of shock, the blood pressure, later, falls until it is represented by the height D H, at which stage, the afferent nerve is again stimulated, and the stimulation is followed by the rise to E I. The absolute height of pressure after the second stimulation (E I) is much very much lower than the absolute height after the first stimulation (C G), but the relation that E I bears to D H is practically the same as the relation that C G bears fo A F. In other words, *in proportion to the blood pressure*, the rise after the second stimulation was the same as after the first stimulation. To this proportional rise, Porter has given the name "percentile."

Our procedure consisted in anæsthetizing dogs by Grehant's method (stomach anæsthesia, with chloroform) connecting the carotid artery with a recording mercury manometer, and dividing both vagi (sometimes low and sometimes high in the neck). Repeated stimulations of the central end of one of the vagi with an induced current gave a fairly constant rise of blood pressure. After the constancy of this rise was determined, the animal's abdomen was opened, and by means of manipulation of the viscera, and the introduction of ice into the peritoneal cavity, a state of shock was induced. As the blood pressure fell, the central end of the vagus was stimulated repeatedly, and each stimulation brought forth a response that was not only as high, but even higher percentilely than was the first response elicited during the normal blood pressure period. These stimulations were repeated up to the time when the pressure became threateningly low (20 mm.), and in every case stimulation was followed by a response indicating not only an active vasomotor center, but a center that was struggling successfully against odds, and maintaining rises that were higher percentilely than those accomplished before the animal organism was compromised. See Fig. 2.

In so far, the results confirm those of Porter, the only difference between our methods lay in the fact that we strived to insure the greatest possible constancy of results by the selection of the vagus, rather than taking one of the mixed sensory motor nerves.[1] But we were able, by the method of percentile rises, to demonstrate not only that the vaso motor center was not exhausted in shock, but even that it maintained its tone to a remarkable degree. We found that for every dog used (dependent upon age, physical condition, or on some other unknown causes), there was a definite strength of current necessary to awaken a vaso motor response. This we determined by starting with a current too weak to call forth any response and then shortening the distance between the primary and secondary coils, until stimulation became effective. The first stimulation that succeeded in calling forth a pressor effect we called the minimal stimulation. A further increase in the strength of the current invariably caused a more pronounced pressor effect, which we termed the maximal stimulation.[2] Here then we secured percentile variations in rise of pressure dependent upon the tonicity of the vasomotor center, and we were able by repeating these maximal and minimal stimulations, to show that even

[1] The use of the vagus also furnished us other valuable data not secured by Porter, in that we were able to note percentile rises with the blood pressure as low as 20 mm., whereas the limit placed by Porter is from 30 to 65 mm. Porter, however, clearly anticipated results such as we secured; for in his Harvey lecture, he states his purpose to investigate the variations in pressor impulses elicited by stimulating the various afferent paths, "nerve by nerve."

[2] These experiments, which are almost directly in line with similar ones carried out by Porter, were completed before we were in possession of Porter's results, and are therefore doubly valuable as independent confirmation. It seems, however, that Porter did not estimate the so-called threshold and maximal values during stages of very low blood pressure.

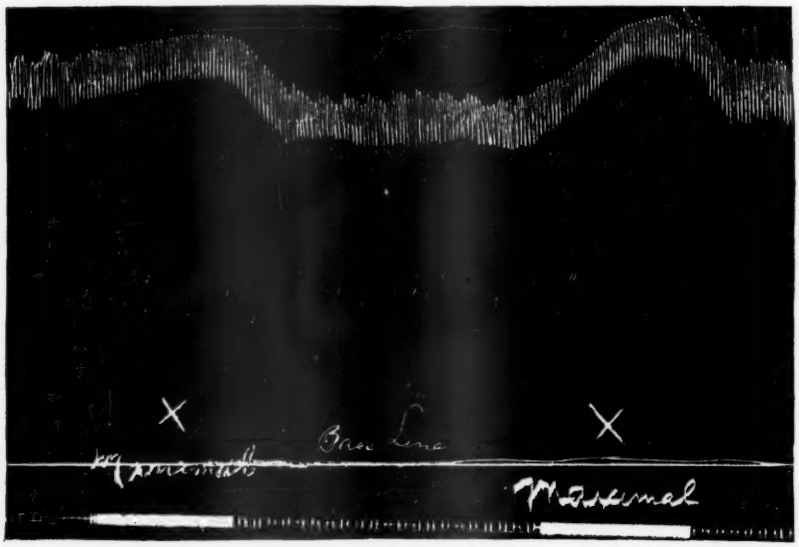


A B

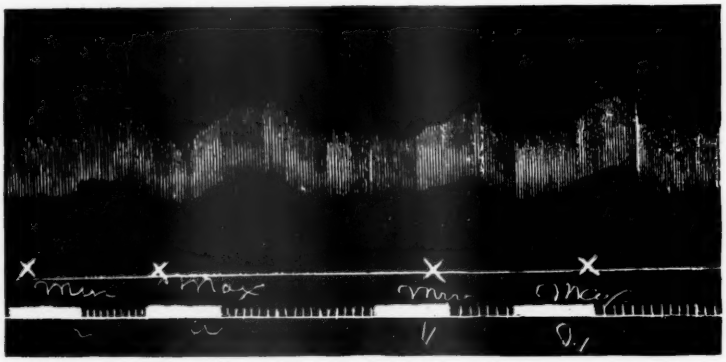
Fig. 2. To illustrate percentile rise. A and B represent two sections of a tracing (A is taken from a portion of the tracing while the pressure is high and B when it is very low). At "X" the central end of vagus is stimulated. The percentile rise is practically identical during high and low pressure.

in the profoundest degree of shock, with the blood pressure alarmingly low, varying strength in the stimuli called forth corresponding rises in pressure. See Fig. 3. It was furthermore interesting to note that the minimal stimulation necessary to call forth a pressor effect remained practically constant both before and after the induction of profound shock, thus suggesting the fact that even in deep shock, the tone of the vaso motor center was not depressed, as regards response to electrical stimulation.

The rise of pressure which invariably followed stimulation of the central end of the vagus must have been due to one or both of two factors: (1) An augmentation of the heart's action or (2) a vasomotor constriction. Here is a problem full of interest, yet by no means easy of solution. The normal physiology of cardiac augmentation, acceleration, and inhibition is by no means definitely settled, and it is, therefore, hardly possible to draw dogmatic conclusions from our experiments along these lines. All of our previous work seemed to show conclusively that there was a distinct vaso motor constriction of the peripheral vascular system, in shock; but we had, so far, not directed close attention to the heart. In this part of the work we assumed that augmentation of the heart is brought about through impulses delivered along the accelerator nerves. These accelerator fibers, passing as they do through the stellate ganglia, can be shunted out of action by removal of these ganglia. This procedure is accomplished with comparative ease, by opening the dog's chest widely in the midline of the sternum (artificial respiration through tracheal canula) retracting



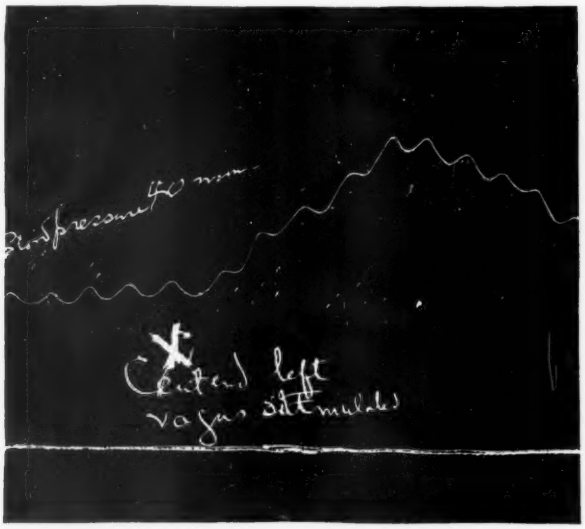
A



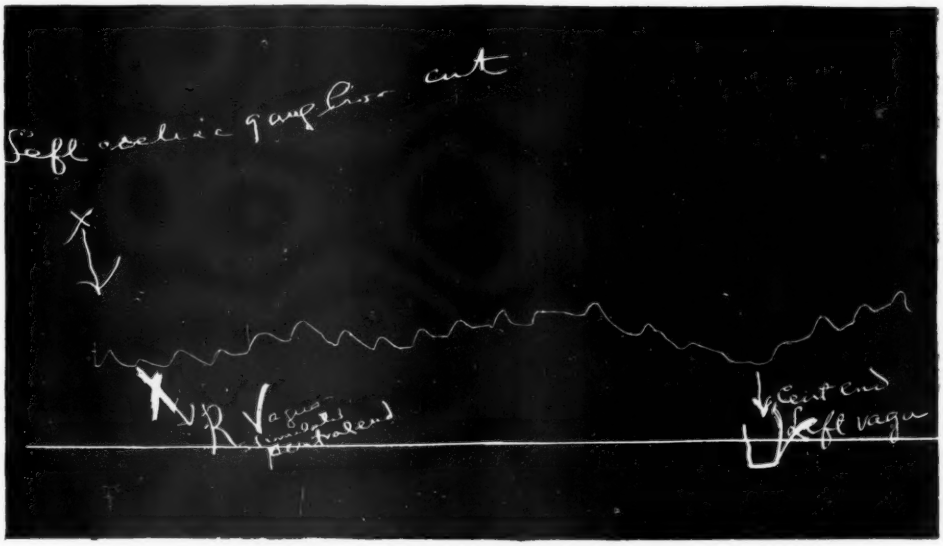
B

Fig. 3. To show persistence of minimal and maximal values. A, blood pressure high. B, blood pressure low (shock). X, stimulation of central end of cut vagus with minimal and maximal stimuli.

the lung toward the middle line, locating the ganglion (just beneath the pleura, near the vertebral column, lying on the ventral surface of the 1st rib) and avulsing it. This procedure was carried out on the right and left side, and then after it was certain that both ganglia were extirpated, the central end of one of the cut vagi was stimulated. An immediate and pronounced pressor effect was the result, and continued to be present in the face of very low pressure. See Fig. 4. We secured this result in dogs varying widely as to age and general condition and furthermore we secured the same result when we excised both cœliac plexuses, in addition to the removal of the stellates. From this it would seem fair to assume that the pressor effects following stimulation of the central end of the vagus are due largely to



A



B

Fig. 4. To show rise of pressure following stimulation of central end of vagus, after extirpation of stellate ganglia (A) and cœliac ganglia (B). These are two sections of one tracing. At X the central end of vagus was stimulated. A rise of pressure occurred in A (stellate ganglia excised) and also in B (stellates and cœliac ganglia excised).

vasomotor constriction and that cardiac augmentation, at least in the later stages of shock[1] is not a primary factor in the rise. In conclusion, it need hardly be emphasized that the results of our work point, in every instance, against the correctness of the theory that shock is a symptom complex due primarily to vasomotor exhaustion.

We desire to express our thanks to Mr. L. Swarts for his aid in the laboratory.

THE PATHOLOGY OF THE THYROID AND HÆMATOLOGY IN ONE HUNDRED GOITROUS CHICAGO DOGS[2]

By AXEL WERELIUS, M. D., Chicago, Illinois
From the Hull Physiological Laboratory, University of Chicago

KOCHER has recently emphasized the diagnostic and prognostic properties of the blood in Graves' disease.

As the thyroid hyperplasia in dogs closely resembles the supposed pathognomonic pathologic condition of thyroid in primary exophthalmic goiter in man, it seemed possible that probably also here the blood would show characteristic changes and it was in order to study the relation between the pathologic and hæmologic pictures in goitrous dogs that this research was done.

PATHOLOGY OF THYROID IN GOITROUS DOGS

The histology of dog thyroid has been extensively and carefully studied by Marine and Williams of Cleveland, who, out of 202 stray dogs, found 90 per cent showing glandular changes.

If the same standard of normal is used, I believe we would find about an equal per cent in Chicago.

Marine divided his thyroids into normal, hyperplastic and colloid.

There is, however, it seems to me, also a mixed type. I have seen in some of these glands interchanging areas of hyperplasia and colloid hypertrophy. This is, though, rather an exception.

Outside of the distinct divisions of the histologic picture of the gland, there are certain complications, but they are very rare and are mainly hæmorrhagic cystic.

GOITER IN CHICAGO DOGS

In palpating 200 stray dogs, I found 86 with goiter, 43 per cent, but the real per cent is much higher and can only accurately be determined by histologic examination of each gland. It seems, though, that Chicago undoubtedly is a goitrous territory for dogs.

In this region I believe a certain degree of hyperplasia to be normal.

In goitrous areas there may be a greater demand for work thrown upon the gland which manifests itself in a cellular proliferation often without any glandular enlargement.

What is the cause of this supposed increased demand for work? Is there, in these regions, a systemic need for a greater than ordinary amount of thyroid secretion, or does the gland give out an inferior grade of secretion, necessitating the manufacturing of a greater amount to satisfy the body want?

Then again, is the disturbing agent in the body intraglandular or extraglandular (systemic)?

The results of my experiments[3] in artificial atrophy of thyroid would speak against the systemic factor; for if extraglandular why should the artificial production of atrophy of one gland cause the opposite gland to diminish in size?

These are highly interesting problems and need much work for elucidation.

As above, I believe hyperplasia to be normal in this territory up to a certain degree, above

[1] The procedure for avulsing the stellate ganglia is certain to induce at least a fair degree of shock.

[2] Read before the Chicago Medical Society, December 1, 1909.

[3] Jour. Am. Med. Assn., July 17, 1909.

which it becomes abnormal; so that we have a physiologic and a pathologic hyperplasia.

Where one ends and the other begins, would, of course, be exceedingly difficult to determine.

A fair estimate probably could be arrived at by studying a large number of animals in regards to symptomatic, metabolic, and pathologic changes. It seems to me that the majority ot dogs that show symptoms are those with large hæmorrhagic cystic glands, and although microscopic section will often show the most marked hyperplasia, symptoms of excessive secretion could not be expected, because there is not enough glandular tissue; hence these dogs show symptoms possibly of hypothyroidism. Symptoms of hypherthyroidism and of distinct myxodœma I have not seen in dogs.

Carlson and Matthews, who have a larger experience with dogs than any other men in this region, never saw Basedow-like symptoms in canines.

Although exophthalmic goiter is not thought to be due to a nervous origin, no one will deny that its external manifestations are those of marked nervous disturbances, and probably, as Dr. Hultgen suggests, it requires a more highly organized nervous system than possessed by the canine species to bring the characteristic phenomena of Graves' disease.

Symptoms of hyperthyroidism (if such a condition exists at all), may manifest themselves in dogs only in slight metabolic changes or otherwise, and would not be noticed except by special examination.

Surely the majority of these goiter dogs exhibit no symptoms, in fact they seem perfectly well. If there is any disturbance at all due to thyroidchange, they are those of deficient, qualitative if not quantitative, gland secretion, and not as one would infer from the pathologic picture, symptoms of hyperthyroidism.

The lack of clinical signs in these dogs must be due to the fact that the animal is in what I would like to term "thyroideous equilibrium," or, in other words, that the thyroid works in full compensation with systemic need.

At first, when the animal gets out of this equilibrium which, of course, has a fairly wide range, then clinical phenomena begin to manifest themselves.

The same applies to the human. If glandular secretion is in excess of systemic need we get our hyperthyroidism, and if in an amount insufficient for body want, there will appear the symptoms of hypothyroidism.

Clinical symptoms of thyroid disturbance do not manifest themselves similarily in man and dog, nor in other groups of mammals (Marine, Williams, Carlson, Canter, Emiguez, Lang, Edmund and others). Thyroidectomy may in some cause the most grave and permanent symptoms; in others only temporary disturbance is noticed, following which the animal seems as well as ever (Carlson); and again in others not the slightest change will be seen.

This difference in symptoms, it seems to me, must be due to the thyroid having different functions in the various groups of mammals; other organs compensating more or less fully for loss of thyroid; or presence of accessory thyroids or nests of thyroid tissue not yet demonstrated.

HÆMATOLOGY IN DOGS

Blood of man and from most of domesticated mammals does not differ materially except in a slight difference in size of the corpuscles. Burnett, who has done a great deal of work on the blood of dogs, gives a table comprising the results of his own and of various investigators.

Below I give the average findings of twelve of these men:

Erythrocytes averaged 7,000,000 per cc. The average size was 7 mic.

Leucocytes, 11,000 per cc.

Hb. 85 per cent.

Sp. gravity, 1.060.

Differential count

Small lymphocytes	20 per cent
Large lymphocytes	7 per cent
Polymorphonuclear	66 per cent
Eosinophiles	7 per cent

SUMMARY OF THE WORK

Color of dogs. Of the single colors there were 12 whites, 11 browns, 9 black, and 3 yellow. Of the mixed colors, there were 12 white, black, and tan, 11 black and white, 11 black and tan, 9 yellow and white, 6 white and brown, 5 white and black, 2 brown, gray, and white, 2 black and brown, 2 gray and tan, 2

white and yellow, 1 yellow and gray, and 1 black, yellow, and gray. The white was the predominating color, then brown, and then black.

Sex. In the human the female is by far more often affected by goiter.

In these dogs, there were 58 males and 42 females; probably the condition occurs about equally in both sexes.

It was interesting to note that male and female were also equally afflicted as to the type of the pathologic process.

There were 16 per cent of colloid and 84 per cent of hyperplasias in both.

In the subdivisions of hyperplasias, there were in males 16 per cent of slight hyperplasia, 26 per cent of moderate, and 33 per cent marked. In the females 25 per cent of slight, 26 per cent of moderate, and 33 per cent of marked hypoplasias. This gives the males a slightly higher per cent of the marked hyperplasias.

Weight of dogs. The average weight of the males was 14 pounds, and the females 11 pounds.

SIZE OF THYROID

In estimating size, a hen egg was used as a standard.

The larger of the two glands was selected.

The average size of all the thyroids was 0.95 per cent of a hen egg, of the males 1.2, and of the females 0.6. The relation between the size of the thyroid and the body weight in the male was about 1–11, and in the female 1–18.

Thus by this somewhat unscientific and approximate method, the glands of the males were found both absolutely and relatively larger than in the female.

In looking over the microscopic specimens, it seemed at first that there was no relation between the size of the thyroid and the degree of hyperplasia, as in some of the smaller glands, I sometimes found the most marked proliferation of cells, but in summing up, I found that in glands smaller than a hen egg only 33 per cent had marked hyperplasia, whereas in those larger than hen egg had as high as 65 per cent.

Slight hyperplasia was present in 20 per cent of those smaller than hen egg and only in 5 per cent of those larger than hen egg. Consequently there is certainly some relation between the size of the thyroid and the degree of hyperplasia.

RELATION BETWEEN SIZE OF GLAND AND COLLOID HYPERTROPHY

In glands smaller than egg there were 12 colloids, in size of egg 4 colloids, in larger than egg 3 colloids. By this it would seem that colloid is oftener present in smaller than the larger gland. This would in some manner support Marine's theory that colloid goiter is only a quiescent stage of hyperplasia or an attempt of reversion towards normal.

RELATION BETWEEN THE DEGREE OF HYPERPLASIA AND AMOUNT OF COLLOID

The degree of hyperplasia was in the main inversely related to the colloid present.

As a rule, the greater the hyperplasia the less colloid and vice versa.

There were 17 specimens in which colloid was absent. Of these there were 11 with marked hyperplasia, about 70 per cent, 4 with moderate 20, per cent, and 2 with slight, about 12 per cent.

Is, in these cases, the increase of cells the cause of diminution of colloid or is the decrease of colloid the cause of cell proliferation? What is the cause of increase or decrease of either?

Carlson has recently advanced the theory that colloid is a stored-up secretion (similar to glycogen in the liver) and when needed it is reabsorbed by the alveolar cell and secreted in the opposite direction, probably directly into the blood. This "storage" theory of Carlson will, it seems to me, beautifully explain the diminished amount or absence of colloid in hyperplastic glands. In these glands the systemic need of thyroid secretions is so great that very little or no "storing up" is possible, hence the lack of colloid.

BLOOD AND LYMPH VESSELS

The blood-vessels were enlarged in all of these glands and in some they were of tremendous size.

In a previous paper,[1] I called attention to the enormous size of the lymph vessels in some of

[1] Jour. Am. Med. Assn., July 17, 1909.

these glands. They seem to bear some relation to the size of the blood-vessels.

CAPSULE OF GLAND

There were in this series: 48 normal, 24 slightly, 10 moderately, and 11 greatly thickened capsules.

STROMA

Was normal in 24, slightly increased in 47, and markedly increased in 29.

ALVEOLI

Were distorted by slight papillomatous ingrowths in 42, moderate ingrowths in 25, and marked ones in 17. The vesicles were overclistened with colloid in 16.

In alveolar spaces there were often seen desquamated epithelial cells, as a rule, isolated, but sometimes several together. At other times only nuclei were seen or the nucleus surrounded by a shred of degenerated protoplasm. At times vesicles were filled with red cells, due to intraglandular hæmorrhage.

In colloids the alveolar walls are often extremely thin and they sometimes give way from colloid overdistension, several vesicles forming one large alveolus.

ALVEOLAR CELLS AND NUCLEI

In the hyperplasia the lining cells were columnar of various heights. Each cell is, as a rule, distinctly demarcated, and I often saw the sharp, dark, intercellular so-called cement lines, described and variously interpreted by Hurtle and others.

The protoplasm is usually granular and sometimes vacuoles may be seen.

The nuclei are large and pale and vesicular.

In the marked hyperplasias, these cells are so packed that in places only a solid mass of epithelial cells will be seen. Due to pressure from overcrowding, cells may assume any form.

In colloid goiter the cells are flattened down and in a few they were so compressed that the nucleus, which I suppose is of a firmer consistency, seemed to project above the less resistant protoplasm.

I was unable to group my specimens as Marine has done from the type and size of the alveolar cell, as it seems to me that they vary greatly in each section.

COLLOID

This was increased in 16, diminished in 52, absent in 17, and seemingly normal in 11.

Colloid, as a rule, stains uniformly and at times it seems somewhat granular. Sometimes vacuoles are seen, but they are probably produced in cutting the tissue.

Colloid is often in the hyperplasias replaced by a pink granular substance.

TYPE OF PATHOLOGIC PROCESS

There were 8 hyperplastic glands, 16 colloid, and 4 mixed.

Of the hyperplasias, there were 42 slight, 25 moderate, and 17 marked ones.

COMPLICATIONS

They are, as Marine states, mainly hæmorrhagic.

He finds it very rare, but in my dogs this complication was not at all unusual, it occurred in nine.

The remaining gland substance in some of these hæmorrhagic cystic glands was very friable and could hardly be cut even with a razor.

Some of these glands are only big cysts in the walls of which there is little glandular tissue and it is in these dogs we do and should have symptoms due to thyroid disturbance. These are the dogs that take anæsthesia poorly.

CLINICAL PHENOMENA

Most of these dogs seemed perfectly well. There were a few that seemed sluggish and apathetic.

There was no exophthalmos.

In another series, I will more carefully observe each dog and note any symptoms present.

BLOOD EXAMINATION

Four specimens were taken from each dog.

Differential counts were made in all the dogs, but the ordinary blood counts only in ten.

Erythrocytes averaged 6,500,000; leucocytes 16,500; hæmaglobin average of all the dogs, 82 per cent.

Lymphocytes (small). The average in all the dogs was 24.8 per cent; in the male 25.2 per cent; in the female 26.8 per cent. In the slight hyperplasias 25 per cent; in the moderate 26.8 per cent; and in the marked hyperplasias 23.8 per cent. In the colloid the average was 21 per cent.

Lymphocytes (large). Average in all dogs 8.6 per cent; in male 8.8 per cent; in female 8.3 per cent. In slight hyperplasias 7.3 per cent; in moderate 9.6 per cent; in marked 9.2 per cent, and in colloids 8.8 per cent.

Polymorphonuclear. Average in all 60.4 per cent; in males 59.8 per cent; in females 58.8 per cent. In slight hyperplasias 64; in moderate 58.6; in marked 59.6 per cent, and in colloids 65 per cent.

Eosinophiles. Average in all 5.8; in male 5.9; in female 5.4; in slight hyperplasias 4; in moderate 4.7; in marked 6.8; and in colloids 6.

Mastcells. Were rare.

By this it seems that there is nothing characteristic in the blood picture, unless the relatively higher polymorphonuclear count and corresponding lower lymphocyte count in the colloids may mean something.

CONCLUSIONS

1. Male and female are about equally affected, both as to presence and type of goiter.

2. Majority of goiter dogs manifest no symptoms referable to thyroid disturbance.

3. If symptoms are present, due to thyroid change, they seem to be those of hypothroidism.

4. There is seemingly a relation between the degree of hyperplasia and the size of the gland.

5. There may be a physiologic and pathologic hyperplasia.

6. By the approximate method used, males have both actually and relatively larger glands than females.

7. Colloid goiter seems oftener present in the smaller and moderate sized glands.

8. In the main, the degree of hyperplasia is inversely related to amount of colloid.

9. There seems to be a type of mixed hyperplasia and colloid.

10. Mammals seemingly differ in their relation of goiter to sex, geographical distribution and to symptoms referred to thyroid change.

11. There is apparently no distinct blood picture in goitrous Chicago dogs.

Only one blood examination of each animal is not sufficient, but this surely is counteracted by the large number of dogs used.

Had there been a marked deviation from the normal, it certainly would have been detected.

I wish to express my thanks to Drs. Moorhead, Johnson, and Simpson for valuable assistance.

CLINICAL EXPERIENCES WITH THE CAMMIDGE REACTION[1]

By BYRD CHARLES WILLIS, M. D., BERNARD FRANCIS McGRATH, M. D., JAMES TAFT PILCHER, M. D., AND DONALD CHURCH BALFOUR, M. D.

UNDER THE DIRECTION OF

LOUIS BLANCHARD WILSON, M. D., ROCHESTER, MINNESOTA

Director of Laboratories and Pathologist, St. Mary's Hospital

THE first work of any considerable extent on the Cammidge reaction in the laboratory of St. Mary's Hospital was that done by Balfour two years ago on eighty cases following closely Mr. Cammidge's technique. This was very discouraging in results and was given up largely because "positive" reactions were obtained frequently on apparently normal individuals.

The examinations were resumed by Pilcher in May, 1909, principally on cases showing more or less symptoms of pancreatic involvement. An effort was made to improve the technique by running parallel tests of hydro-

[1] Read before the Association of American Physicians, Washington, D. C., May, 1910.

lyzed and unhydrolyzed specimens. The cases were studied clinically by Pilcher at the time of making the tests, after the manner described by Mr. Cammidge. They were also seen by Pilcher at operation. The results, which have been published elsewhere,[1] appeared on their face to warrant further study of the test as an aid to clinical diagnosis. Thus of 62 patients at operation showing involvement of the pancreas, 50 gave more or less "positive" reactions; of 50 cases showing at operation no pancreatic involvement, 7 gave more or less "positive" reactions; and of 25 "well" individuals, 1 gave a "positive" reaction. There was a feeling on the laboratory staff, however, that there were great possibilities of error in this method of working, not only owing to the indefiniteness of what actually constituted a reaction — due to great variation in color changes, amount of precipitate, type of crystals, relation of controls, etc.,— but also to the difficulty of eliminating bias in judgment when the laboratory technician was familiar with the clinical history of the case under consideration.

Willis and McGrath therefore took up the study along with Pilcher, five months ago, seeking first to attain a uniform technique, second, to analyze the types of reaction, and third, to eliminate the personal equation by having the end reactions classified by one (Pilcher) who knew nothing of the patient.

The cases were clinically of four classes: (1) cases shown at operation or autopsy to have involvement of pancreas; (2) cases (with abdominal or pelvic lesions) which at operation or autopsy were shown to have no involvement of the pancreas; (3) sick individuals in whom the pancreas was not examined; and (4) apparently well individuals.

TECHNIQUE

The specimens of urine were 24 hour, or mixed evening and morning collections. These were sent to the laboratory in well stopped bottles immediately after the last portion of the specimen was collected. The specific gravities and reactions were taken. The specimens were then filtered through double filter papers into two beakers, graduated for 40 cc., and 5 cc. was taken to test for albumin and sugar tests. For the latter, two parts of urine to one of Fehling's solution was used, heating both separately, and then pouring together and allowing to stand.

[1] Annals of Surgery, 1910, vol. li, pp. 88–109.

When a trace of albumin was found the specimens were acidified with dilute acetic acid, boiled, and refiltered.

If the specimen was alkaline (very few) it was acidified with dilute acetic acid.

In making the Cammidge tests proper all glassware was thoroughly rinsed and all filter papers well moistened with distilled water. The two 40 cc. samples of each urine were numbered. To the specimen to be hydrolyzed was added 2 cc. c. p. HCL, sp. gr. 1.20 (Grasselli). The specimen was gently boiled on the sandbath for 10 minutes, with recondensing funnels in place, then transferred into racks to cool in running water. At this point when necessary (seldom) distilled water was added to bring the amount up to 40 cc. Eight grams of pure lead carbonate (Mallinckrodt's) was slowly added to the specimen which was thoroughly shaken and was then allowed to stand five or ten minutes for completion of neutralization. It was passed through double moist filter papers until perfectly clear. The unhydrolyzed control without previous preparation was from this point run parallel to the hydrolyzed. Eight grams of pure tribasic lead acetate (Merck) was added slowly to each specimen, which was then well shaken and allowed to stand from ten to fifteen minutes, and then filtered through double moist filter papers until clear. To each 4 grams pure sodium sulphate (Mallinckrodt) was now added, and the specimens brought to a boil on a sandbath, then cooled in running tap water, and filtered through moistened filter paper. To 10 cc. of the clear filtrate were added successively 1 cc. 50 per cent acetic acid, 7 cc. distilled water, 2 grams pure sodium acetate (Mallinckrodt) and 0.8 gram phenylhydrazine hydrochlorate (Merck). The specimens were then boiled for 10 minutes on the sandbath. Lastly the specimens were filtered hot, through filter paper moistened with hot water, into test tubes. Owing to the use of funnel recondensers the final amounts were uniformly approximately 15 cc. The tubes were then set aside at a temperature of about 5° C.

For accuracy of results and convenience in handling large numbers of specimens at once, tall beaker glasses (capacity 170 cc., height 11 cm., diameter at top 5 cm.) were used. A copper waterbath (64 cm. in length 33 cm. wide, 6 cm. deep and containing in cover 32 circular apertures 5 cm. in diameter) was used for cooling the solutions in beakers. A reinforced sheet iron pan with wire rack cover was used for a sandbath, and gave very uniform heating. From eight to fifteen specimens (i. e. 16 to 30 tests) were carried through at one time by two men working together, one analyzing the specimens to be hydrolyzed, and the other the controls. To facilitate the work four sets of glassware were prepared in advance. All chemicals were carefully weighed in sets at the same time. When once the analyses were begun they were pushed to completion as rapidly as possible, it usually requiring about 3 hours to complete a day's tests. In addition to the above no pains were spared to make the tests as uniform as possible, even in the most minute detail.

PRELIMINARY TESTS

1. SUGAR

In doing the Fehling's test for sugar a careful record of the colors was kept after the tubes had stood several hours, and three groups adopted:

1. Bluish color; 48 tests, 22 of which in the Cammidge test had some form of crystal in either or both of the hydrolyzed or unhydrolyzed specimen. Thirteen of the 22 crystalline end reactions were "positive" Cammidge reactions.

2. Greenish color; 252 tests, 197 of which in the Cammidge test had some form of crystal in either or both, of the hydrolyzed or unhydrolyzed specimen. Seventy-four of the 197 crystalline end reactions were "positive" Cammidge reactions.

3. Reddish color; 206 tests, 188 of which in the Cammidge test had some form of crystal in either or both of the hydrolyzed and unhydrolyzed specimen. Seventy-four of the 188 crystalline end reactions were "positive" Cammidge reactions.

There were 23 urines which gave Fehling's reaction for sugar, seven of which gave positive Cammidge crystals. A number of the sugar specimens were fermented for 24 hours with yeast, and in no case was a crystal obtained subsequently by Cammidge test. A number of urines (same specimens) that had given what were considered most typically positive Cammidge reactions, were fermented with yeast for 24 hours, and subsequently tested for Cammidge crystals. None whatsoever found.

2. SPECIFIC GRAVITY

The apparent relationship of the specific gravity and the Cammidge end reactions is shown in the following table:

Specific Gravity.	No. of cases.	Results of Cammidge tests.	
1025–1039	208	88 positive	42.3 per cent
1015–1024	239	66 positive	27.6 per cent
1001–1014	56	12 positive	21.4 per cent

3. CAMMIDGE END REACTIONS

As soon as the decision as to what constituted a positive end reaction was made to rest solely on the contents of the test tubes it became evident that the diagnostician with the greatest experience (Pilcher) was frequently unable to decide the value of the various colors, precipitates, and crystals, while others with less experience were wholly at sea.

An effort was made therefore to analyze and classify the various factors of the end reaction in order not only to have some uniform nomenclature for recording our observations but also to determine what valuation should be placed on each variant, With this in view the following 19 types of hypothetical end reactions were adopted:

VARIETIES OF REACTIONS IN CAMMIDGE'S "C" TEST

Examination of tubes made after standing 18 to 24 hours, at about 5° C.

Variety	End Reaction of HCL Specimen	Diagnostic Significance	End reaction of Control	No. end reactions in each
1	No change	Negative	No change	95
2	Orange color only	Very doubtful	No change	4
4	Amorphous precipitate	Very doubtful	No change	2
5	Amorphous precipitate	Very doubtful	Amorphous precipitate	2
6	Amorphous precipitate	Very doubtful	Atypical crystals	10
7	Atypical crystals	Doubtful	No change	37
8	Atypical crystals	Doubtful	Amorphous precipitate	17
9	Atypical crystals	Doubtful	Atypical crystals	113
10	Typical crystals	"Positive"	No change	21
11	Typical crystals	Very suspicious	Amorphous precipitate	7
12	Typical crystals	Very suspicious	Atypical crystals	72
14	No change	Negative	Amorphous precipitate	6
15	No change	Negative	Atypical crystal	42
16	Orange color	Doubtful	Atypical crystals	1
17	Typical crystals	Very suspicious	Typical crystals	61
18	Atypical crystals	Negative	Typical crystals	11
19	No change	Negative	Typical crystals	3
				504

Two of these types of hypothetical end reactions (three and thirteen) were found not to occur, and they have been purposely omitted in the preceding table.

As nearly as can be determined from Mr. Cammidge's somewhat indefinite description of his end reaction probably four — Nos. 10, 11, 12, and 17 — of these types would be (by him) considered positive and the remainder negative.

On this basis, in which we have followed Mr. Cammidge as accurately as possible, the results of our 504 tests may be analyzed as follows:

GROUP 1. PATIENTS WITH PANCREAS INVOLVED

In this group there were 26 cases, 17 of which were examined before operation. Of these 6

gave positive reactions. Of the same 26 cases examined 5 days after the operation 6 were positive, three of these having been positive before operation, one negative and two not previously examined.

Twenty-four of these cases were examined about the ninth day after operation, and three gave positive reactions. These three had all been positive at the examination before operation. One had been positive on the second test, and the other two negative.

GROUP 2. PATIENTS WITH PANCREAS NOT INVOLVED

In this group containing seventy-four cases, 26 were examined before operation. Of these 16 were positive. Five days after operation all 74 were again examined, and 21 were positive. Four of these had been positive before operation, two had been negative, and the remaining fifteen had not been previously examined. About nine days after operation 69 of these cases were again examined. Seventeen were positive. Of these five had been positive before operation, one had been negative, and the remaining eleven not examined before operation. Twelve of the seventeen cases had been positive five days after operation.

GROUP 3. SICK PERSONS WHOSE PANCREAS WERE NOT EXAMINED BUT WHO EXHIBITED NO RECOGNIZABLE SYMPTOMS OF PANCREATITIS

In this group 207 cases were examined. Seventy-three of these were positive. Of these 73 positives 17 were goiter cases (44 goiter cases in all being examined) 9 were appendicitis cases, and the remainder were cases of salpingitis, uterine tumors, etc.

GROUP 4. APPARENTLY WELL PERSONS (MEMBERS OF THE HOSPITAL STAFF)

In this group 17 cases were examined from one to five times each. Of these 5 were positive.

It will thus be seen that of the 26 patients who were shown to have pancreatitis (group 1) only 9 (35 per cent) gave a positive reaction and, even of these, 7 in one or more of the series of three tests gave negative results. Of the 74 sick persons without pancreatitis (group 2) 35 (47 per cent) gave one or more positive reactions. Of the 207 sick persons who in all probability had no pancreatitis (group 3) 73 (35 per cent) were positive. Of the 17 well persons 5 (30 per cent) were positive.

SUMMARY

From the foregoing it is apparent:

1. That even where the most elaborate care is exercised to follow the technique of Mr. Cammidge's "C" reaction, in the most uniform manner, *if knowledge of the clinical histories and other factors of the personal equation be eliminated*, the end results, judged by Mr. Cammidge's own criteria, must be considered, as a means of diagnosing disease of the pancreas, as both valueless and misleading.

2. There is no apparent clinical relationship between disease of the pancreas and any of our various types of end reaction.

3. It does not seem to us that the end reactions are artifacts but rather that they indicate actual metabolic variations. The relationship of these changes in metabolism to the welfare of the patient is not apparent.

ON THE TREATMENT OF TRAUMATIC INJURIES OF THE LUNGS AND PLEURÆ

WITH THE PRESENTATION OF A NEW INTRATRACHEAL TUBE FOR USE IN ARTIFICIAL RESPIRATION

BY GEORGE MORRIS DORRANCE, M. D.,[1] PHILADELPHIA, PENNSYLVANIA
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(From the Experiment Surgical Laboratory in the University of Pennsylvania)

THE present study of injuries of the lungs and pleuræ was suggested by some of the problems that presented themselves for solution during the management of several cases of thoracic injury which the author had encountered in his practice. It seems to him that this branch of surgery has not received the attention which its importance deserves, and that various problems relating to the technique of lung surgery still await solution. Thus, for example, the treatment of traumatic hæmothorax has hitherto been almost purely expectant, no attempt being made to treat the condition like any other accumulation of blood in other portions of the body, namely, by removing the clots and serum and controlling the bleeding points by ligation or otherwise. Much of the experimental work reported in this paper refers to this question of the management of traumatic hæmothorax, a complication on which also the author's classification of perforating wounds of the chest is based.

When the experimental work which forms the basis of this paper was begun, it was intended to include a study of tuberculous lesions of the lungs, with a view to testing the practicability of certain surgical procedures that have recently been proposed in various quarters.

Thus, P. L. Friedrich [2] proposes "total pleuropneumolysis," or resection of the chest wall overlying a tuberculous lung, with the object of bringing about collapse of the lung and thereby hastening contraction and healing of the cavernous tissue. He states that the procedure leads to (1) collapse of cavernous lung tissue; (2) marked functional restriction of the lung on the side of the operation; (3) retardation of pulmonary circulation; and (4) diminution of lymphatic circulation and absorption. The procedure, according to its author, is applicable only to "cases of unilateral phthisis in which the other side is not affected with active, progressive foci, passive processes alone being present." Leonard Freeman, who deprecates such radical measures as pneumonectomy, pneumonotomy and Friedrich's "osteoplastic pneumolysis" — as he calls it [3] — regards as "one of the most potent factors in the cure of pulmonary tuberculosis, with or without the presence of cavities, the gradual formation and contraction of fibrous tissue, which seems to be promoted by collapse of the lung and freedom from motion." He enumerates the following methods of obtaining pulmonary collapse: (1) the production of an artificial pneumothorax (Murphy, Forlanini); (2) extrapleural resection of nearly all the ribs below the first, from their cartilages to the spine, and including their periosteum (Friedrich); (3) removal of portions of some of the ribs, with their periosteum, along the axillary line (Quincke, Spengler, Turban, Landerer, Garré, and others); (4) resection of portions of several ribs and their periosteum directly over the diseased part of the lung, usually a cavity near the apex; (5) Freeman's own contribution, resection of two or three ribs near the apex, without the removal of the periosteum, followed by external pressure by means of a truss. He restricts the indications for operative interference within even narrower limits than Friedrich, and recommends his own method only in cases with marked and limited apical lesions, or as an adjunct to artificial pneumothorax.

Aside from the fact that these radical

[2] Annals of Surgery, July 1, 1900, p. 135.

[3] Loc. cit., p. 145.

[1] Dr. C. C. Burleigh, Dr. Richard Hopkinson, and Dr. Hunter Scarlett, of the Medical School, assisted in the above experiments. Dr. McIlhone, Dr. Hayward, and Dr. Pitt, of the Dental School, assisted in the respiratory portion of the paper. I want to thank Dr. Allen J. Smith for his numerous suggestions and advice, and also for the many kindnesses shown me.

attempts in lung surgery have, on their authors' own showing, only a very limited application and have so far met with but small success, it does not seem rational on general physiologic and pathologic grounds that the mere healing of the local lesion, like a surgical injury, should, in any marked degree, influence the progress of a systematic infection like pulmonary tuberculosis. Moreover, there is to be reckoned with the practical difficulty of obtaining suitable experimental material. It is not possible to produce the pulmonary lesions of tuberculosis by inoculation, as the animals invariably die of general miliary tuberculosis. Pulmonary abscess, gangrene, and bronchiectatic cavities have always been suitable conditions for surgical intervention, and it is possible that the scope of lung surgery may in the future be extended to include certain cases of lobar pneumonia with delayed resolution before positive signs of abscess or gangrene have made their appearance; but, for the present, the treatment of pulmonary tuberculosis, aside from complications and sequelæ, must still be regarded as belonging exclusively to the sphere of internal medicine.

PHYSIOLOGIC AND PATHOLOGIC POINTS OF INTEREST

1. The pleural cavity is a negative chamber in which the air pressure varies with the movements of the air, but never becomes positive.

2. The influence of negative and positive pressure during the respiratory act does not extend beyond the large bronchi; from there the oxygen in the inspired air is distributed to the air vesicles by diffusion. That is to say, the inspired air is not carried all the way to the air cells by the inspiratory act — a point of very great practical importance which is not sufficiently appreciated by clinicians.

3. Constriction or compression of the chest wall at any one point produces a uniform compression of the entire lung, and does not affect that portion immediately underlying the constriction more than any other part of the lung, providing there are no adhesions; in other words, pressure in the pleural cavity is equally transmitted to all parts of the lung. This point has apparently been overlooked in the discussion of subperiosteal resection of the ribs for the cure of tuberculous lesions.

4. Adhesions between the lung and the parietal pleura limit the expansion of the affected lobe, and also diminish the excursion of the lung as a whole. Hence, while compression of the thorax affects the expansion of the adherent portion more than that of the rest of the lung, it nevertheless also modifies pulmonary expansion as a whole.

5. It has been suggested that the introduction of pure oxygen into the lung through a laryngeal tube, in excess of the quantity required for normal respiration, will obviate the necessity of employing positive air pressure, i. e., sufficient pressure to overcome the collapse of the lung. This point is definitely settled by Paul Bret in his work on atmospheric pressure [1] in which he calls attention to the fact that oxygen under pressure is not only unnecessary, but even toxic, and possibly fatal. From experiments made on a large number and variety of animals and plants he concludes that all living things are killed when the tension of oxygen employed is sufficiently high, say 300 or 400 per cent. Warm-blooded animals die in convulsions when subjected to a pressure of three atmospheres of pure oxygen, or fifteen atmospheres of atmospheric air. At this high pressure the blood contains 300 volumes of oxygen. Fish are killed when the oxygen tension is increased to such a point that the water contains 10 volumes of dissolved oxygen to each 100 cc. of fluid.

J. Lorraine Smith [2] showed that oxygen at the tension of the atmosphere stimulates the pulmonary alveoli to active absorption, while at a higher tension it acts as an irritant or pathologic stimulant and produces inflammation of the lungs. No adequate chemical explanation can at present be offered for this action at high tension, although the question is of considerable importance.

6. It has been suggested that the introduction into the lungs of a continuous current of air under pressure sufficient to overcome pulmonary collapse, through a tube introduced into the trachea, would cause sufficient gaseous interchange in the air vesicles. The possibility

[1] La Pression Barométrique, p. 764, Paris, 1878.
[2] Journal of Physiology, 1899.

of thus maintaining sufficient oxygenation of the blood when the chest is opened finds support in one of the author's experiments. Both sides of the chest were opened, and for ten minutes a current of air, obtained from the positive pressure tank in the laboratory, was forced into the trachea through a tube which permitted some of the air to escape around it. The pressure was varied from time to time so as to cause a moderate change in the distension of the lung. The dog recovered from the anæsthetic and walked about the operating room for some time before it was killed for autopsy (No. 34).

In another experiment the tube was placed in the larynx and connected with a Matas positive pressure pump, but the apparatus apparently did not give sufficient pressure to effect oxygenation of the blood, and the animal expired (No. 35). A third trial was made with dog No. 36, but as the artificial respiration was not satisfactory, the author's intratracheal tube, presently to be described, was used instead of the Fell-O'Dwyer tube with which the Matas apparatus is equipped.

The author believes that, if the pressure employed is sufficient to force the air directly into the air vesicles, harmful results are likely to ensue. The method also has the disadvantage of necessitating the employment of cumbersome apparatus, which is not readily portable. In most cases, if the operator works rapidly, artificial respiration is not necessary in the human subject; cases occur, however, in which an apparatus of some kind to propel the air into the bronchi for the purpose of keeping up artificial respiration is indispensable. It is of value also at the end of the operative procedure for inflating the lungs and preventing the formation of pneumothorax.

7. Opening one pleural cavity in the human subject causes a slight embarrassment of respiration in the opposite lung, but does not abolish the act altogether. The interpleural membrane is distended toward the unopened side, providing there is no communication between the two cavities. Such communications are generally believed to be fairly common, and in order to determine their frequency, the author examined 100 cadavers, 84 male and 16 female, with the following results:

Interpleural communication. In all but one there was no communication between the two pleural cavities. In the single exception the opening in the interpleural membrane, which was very thin, measured 3 millimeters in diameter. Even in this case, as the abnormality was discovered in the dissecting-room, the possibility of artifact cannot be absolutely excluded.

The mobility of the intrapleural membrane varied from absolute fixation to an excursion of 5 centimeters (2 inches), the average being about 2.54 centimeters (1 inch). These variations are due to adhesions. In cadavers having no pleural adhesions the membranes, with very few exceptions, were in apposition.

Membranes in apposition	in 67 cadavers
Interval of 4.2 mm. ($\frac{1}{6}$ inch)	in 6 cadavers
Interval of 6.3 mm. ($\frac{1}{4}$ inch)	in 17 cadavers
Interval of 12.7 mm. ($\frac{1}{2}$ inch)	in 10 cadavers
	100

Pleural adhesions. The findings with regard to the presence of adhesions were as follows:

No adhesions	in 49 cadavers
Bilateral adhesions	in 27 cadavers

(In 5 cadavers very few in number.)

Right side only	in 19 cadavers
Left side only	in 5 cadavers
	100

ARTIFICIAL RESPIRATION DURING OPERATIVE PNEUMOTHORAX

Before pulmonary surgery could attain any degree of perfection it was necessary to devise some apparatus for keeping up artificial respiration during operative procedures on the opened thoracic cavity. The earliest attempts in this direction that attained any success date from 1902, when Rudolph Matas brought out his first model of an "experimental automatic respiratory apparatus," which at the time did not attract much attention.[1] Two years later Sauerbruch perfected his negative chamber or cabinet — a large, airtight apartment, with an adjoining smaller space which is used as a lock to permit the operator to enter and leave the

[1] American Medicine, January 18, 1902.

cabinet. The animal's or patient's head projects through an opening in the wall of the chamber, while the surgeon remains inside. A slight negative pressure is maintained within the chamber by means of an air pump. The appearance of this apparatus was almost immediately followed by that of L. Brauer's positive chamber or box, with a small capacity of about one-half of a cubic meter. The patient's head is inserted into the box, the body remaining outside, and the surgeon performs his work outside of the cabinet. Hermetic closure is effected by means of a tightly fitting rubber collar around the patient's neck. The cabinet is provided with a window immediately over the patient's or animal's face, and two openings for the anæsthetizer's hands. The air pressure in Brauer's box is positive and is controlled by means of an air pump or atomizer bulb.

These two forms of apparatus, which illustrate one type of artificial respiratory apparatus in lung surgery, with a third, namely, a modification of Sauerbruch's chamber by Willy Meyer of New York, are open to the same objections. They are cumbersome, complicated, expensive, and cannot be readily transported from place to place. Sauerbruch's chamber, the cost of which is not less than twelve hundred dollars, requires the constant presence of a corps of trained assistants. The Meyer chamber is somewhat less complicated. It is collapsible and can be moved about from one part of the hospital to another, but it cannot be called a portable apparatus. Another objection to these cabinets is that they require a power pump for the control of the air pressure in so large a space. The latter objection does not obtain in the case of Brauer's box or cabinet, which is also less cumbersome and less expensive. Its disadvantages are, however, the danger of getting out of order during the operation, thereby endangering the patient's life, and the added difficulties of anæsthetization.

The use of negative or positive cabinets never became popular among American surgeons, who developed instead different types of intralaryngeal tubes for the direct introduction of air into the lungs from an air pump especially devised for the purpose.

An exception must be made in regard to Samuel Robinson of Boston, who in 1908 devised a helmet similar to that of a diver's helmet, which is fitted hermetically over the patient's head and attached to an air pump, by means of which air, or the vapors of chloroform or ether necessary for anæsthesia, are introduced into the helmet. This contrivance is suitable for laboratory use only, being far too complicated and too liable to get out of order, for use on the human subject. If the patient vomits, or the tongue falls back on the epiglottis, the operator is unable to remedy the trouble without interrupting artificial respiration, and incurring all the risks incident to such a procedure. Recently Robinson devised a second, somewhat less complicated model for use in human surgery, with a portable electric air pump.

The use of positive pressure by means of an air pump was at once criticised by Sauerbruch, who raised the following objections to this method of procedure: (1) The change in the method of breathing, that is to say, rhythmical, mechanical inflation of the lungs, regardless of the normal reflex mechanism of breathing; (2) the development of interstitial emphysema of the lungs as the result of artificial in-pumping of air; (3) the effect on the circulation; (4) the persistence of a pneumothorax after artificial inflation has been discontinued; (5) the great loss of heat; (6) the great danger of infection to the pleura as the result of an extensive air exchange in the pleural cavity; (7) the necessity of tracheotomy; (8) the difficulty of anæsthetization.

Some of these objections, such as the fifth and sixth, do not require special contradiction, as experience has abundantly proved that they are unfounded.

With regard to the remainder, it may be submitted, in answer to the first, that with a positive pressure apparatus the operator can supply the air at the instant when the patient begins his inspiratory movement, and thus perfectly adapt artificial inspiration and expiration to the normal function of breathing as controlled by the reflex mechanism of respiration. At times when the breathing is proceeding normally, the air pump may be stopped at will.

With regard to the second objection, other observers as well as the author deny ever having observed interstitial emphysema of the lungs as a result of artificial respiration in any of their experimental or clinical work.

With regard to the third objection, the following may be quoted from Robinson:[1] "I believe, however, that if the resistance to the lung is not carried to excess, the normal relations between the general and pulmonary pressures will be little disturbed. I add one of a series of tracings which I made to show the comparatively slight respiratory and circulatory disturbances which occur in the course of such operations as the above under positive pressure." In a later article[2] he says: "Thirty operations and twenty-five experiments proved that emphysema and circulatory changes do not occur with a properly regulated apparatus."

The persistence of pneumothorax after artificial inflation has been discontinued has not occurred in the hands of Robinson or Green, and was not noted by the author in any of his experiments.

The necessity of tracheotomy is obviated in the author's work by the use of his intratracheal tube, which is described in another place.

Finally, with regard to the eighth and last objection of Sauerbruch, it was found that etherization as well as artificial respiration could be perfectly controlled with Matas' positive pressure apparatus and the author's intratracheal tube.

Under the head of positive pressure apparatus should also be mentioned Fell's bellows, fitted with a Fell-O'Dwyer tube for conveying the air into the larynx. This instrument has not proved satisfactory, as the quantity of air insufflated cannot be accurately gauged, and the suction of the bellows creates a negative pressure which withdraws the air from the bronchi before it has been diffused into the air cells of the lung.

Of the various devices for supplying the air necessary for artificial respiration, such as the Hoyt pump used by Green, Robinson's electric motor pump, and others, the author after a careful study of the subject decided on the choice of Matas' second model of "automatic respiratory apparatus" for use in surgical and medical practice. Matas' first instrument was a duplex pump, which he discarded.[3] Matas found that the expiratory moiety of artificial respiration was unnecessary in practice, and that in order to maintain respiration it is only necessary that the apparatus used shall insufflate air into the lungs in sufficient quantity and under suitable pressure. The degree of positive pressure which Matas and others have found to be suitable is from 6 to 8 mm. of mercury.

Matas' second model, or clinical respiratory apparatus, is composed of the following parts (Fig. 1):

The pump (A), with separate openings for the intake (1) and exit (2) of the air so that there is no possibility of the patient's breathing the same air twice. The opening and closing of these apertures (1 and 2) are effected by means of three openings in the cylinder (3), which are brought into communication at the proper moment with the intake and exit apertures (1 and 2) through the action of the piston rod (4). By means of the thumb screw (5) on this rod the capacity of the pump can be regulated in such a manner that the quantity of air injected with each stroke of the piston varies from 1 to 43 cubic inches.

The filter box (6), connected with the exit opening serves to remove the impurities from the respiratory air.

The apparatus is also provided with three bottles interposed between the filter box and the larynx. The connection is effected by means of rubber tubing, and one or all of the bottles can be connected and disconnected at will by means of clamps. The bottles are from three to five inches in height by two and one-half inches in diameter, and the rubber stoppers are pierced by two openings for the passage of two nickel-plated tubes. One of these extends down to within one-half inch of the liquid contained in the bottle, while the other, or exit tube, is short and merely serves to carry off the air. According to Matas' directions these bottles are to contain ether, chloroform, and water respectively, and with such an arrangement either air alone or one or the other

[1] Annals of Surgery, 1908, vol. xlvii, p. 220.

[2] Journal A. M. A., September 5, 1908, p. 803.

[3] A description of the apparatus is found in his article on Artificial Respiration by Direct Intralaryngeal Intubation, etc., American Medicine, January 18, 1902.

anæsthetic may be administered to the patient by clamping off the rubber tubes leading to the other two bottles. The water in one of the bottles serves to provide the necessary moisture for the respiratory air. The author in his work filled one of the bottles with ether and the other two with water, obtaining in this way the proper dilution of ether for the anæsthesia. If at any moment it is desired to increase or diminish the percentage of ether, this can readily be done by manipulating the clamps.

The exits converge at a common center and are connected by a rubber tube of varying length, either with a modified Fell-O'Dwyer canula or the author's intratracheal pressure bulb tube.

For the purpose of regulating the degree of air pressure employed a manometer (9) may be interposed at any convenient point between the pump and the larynx.

Matas' modification of the Fell-O'Dwyer canula, with assorted laryngeal tips, is shown in Fig. 1.

The special features of Matas' pump are summarized by its author in the following paragraphs:

1. It is a graduated pump which can be readily adjusted to any quantity of air required, from 1 to 700 cm. (or 1 to 43 cubic inches).

2. It is provided with a mercurial manometer, which indicates the intrapulmonary pressure and is an index to the peripheral resistance that is overcome by the insufflation.

3. It is provided with an automatic cut-off which effectually prevents any backward leakage of air into the cylinder, and thus puts the inspiratory inflation of the lungs under the control of the operator, who regulates the duration of the inspiratory act and thereby the rhythm of the respiration.

4. It is provided with an air filter, interposed between the larynx and the pump which purifies the air injected through the pump.

5. The inlet opening of the pump can be readily adjusted to a screened funnel and tube for further administration of chloroform or oxygen while artificial respiration is going on.

6. It is provided with an intralaryngeal canula of the O'Dwyer type, with several adjustable conical tips for intubation. Our (Matas') modified canula differs from the O'Dwyer canula in the shape of the handle, which is pistol-shaped and gives a firm grip, and in having an opening guarded with a stopcock which is easily connected to a tube and funnel for the administration of chloroform while the patient is breathing through the intubating canula. While insufflation is going on, the stopcock is closed and the anæsthetic is administered through the inlet in the pump.

Laryngeal tubes. Some form of canula or tube is necessary in connection with the positive pressure apparatus, whatever type may be employed. The original Fell bellows were fitted with the Fell-O'Dwyer tube, which is too familiar to surgeons to need special description (Fig. 1). Suffice it to say that it labors under a number of disadvantages; great difficulty of introduction; difficulty of keeping the tube in place; danger of injury to the laryngeal tissues when used by inexperienced hands, or when the patient is only partially anæsthetized.

A modification of the Fell-O'Dwyer tube was devised by Matas for use with his apparatus. This modification consists, in the main, in fitting the tube to a pistol-grip or introducer, and slightly altering the curve of the tip. While the Matas tube is more readily held in place than its prototype, it is open to the same objections urged against that instrument.

Other types that may be mentioned are Chaussier's intralaryngeal canula; Doyen's canula, and Trendelenburg's tracheotomy canula. These instruments, like the O'Dwyer and Matas tubes are rigid and made of metal, and are therefore open to the common objection of difficult introduction and danger of injury to the laryngeal or tracheal tissues.

In 1906, N. W. Green, of New York, proposed a new intralaryngeal canula or tube, the body of which was made of flexible rubber ending in a metal tip or canula, surrounded by a soft rubber, inflatable cuff or bulb. A small caliber rubber tube was carried from the bulb inside of the main tube, and the canula was held in place within the larynx by inflating the bulb through this accessory tube, which was then clamped off. A specially devised introducer was necessary for the introduction of the tube. The following year Green brought out a second model similar to the first, except that

"the body, instead of being made of flexible rubber, consists of an 8 mm. brass tube 12 inches long, slightly curved and rounded at the laryngeal end, and supplied with an obturator which tightly fits the rima glottidis. The obturator consists merely of a few turns of adhesive plaster so wound around the tube as to make a fusiform enlargement of about 12 mm. at its maximum diameter." At the aboral end the tube is provided with a vent which can be closed by a sliding collar of rubber tubing. This tube also requires a special introducer and is held in place by means of an Otis metal dilator applied to the outside of the neck at a point above the hyoid bone.[1]

Much the same objections may be urged against this tube as have been mentioned with regard to the earlier devices. Its rigidity, the difficulty of keeping it in place in the larynx, which suggested the use of an external clamp, as described; and the danger of injury to the laryngeal tissues by the rather crude, non-elastic adhesive plaster obturator, especially in the case of a patient in incomplete anæsthesia. For the latter reason also the tube is applicable only in operative work and is not available for emergency cases requiring artificial respiration, such as opium poisoning, drowning, asphyxia neonatorum, and the like.

Author's intratracheal pressure bulb tube. A thoroughly practicable apparatus for the employment of artificial respiration during operations on the thorax must satisfy the following conditions:

1. It must be simple enough to be readily used by any surgeon of average skill and experience.

2. It must be simple in construction so that there may be no danger of its failing to work at a critical moment during the operation.

3. It must be cheap and durable, and must not easily get out of order.

4. It must be portable.

5. The apparatus must be capable of being operated by hand-power in case the electric or other form of motor breaks down at a critical moment.

6. There must be no danger to the laryngeal tissues.

In the author's opinion, the Matas clinical respiratory apparatus with his own intratracheal pressure bulb tube (Fig. 2, p. 169), closely approximates the above specifications. The tube is made of soft rubber, and in different sizes, from the size of a No. 30 French catheter for adults, to a No. 15 for infants. Near the tip it is surrounded by an inflatable bulb or cuff, made of thin rubber tissue like a dentist's rubber dam, which holds the tube firmly within the trachea and prevents regurgitation of air along the outside of the tube. The bulb is inflated by a small rubber tube, 2 mm. in diameter, which passes outside of the main tube and is independent of it except at the point where it enters the bulb. The inflating tube is provided with a mouthpiece and a clamp or serrefine, which latter is attached by a short chain to the hard rubber or metal mouthpiece. The intratracheal tube is threaded on a flexible wire stylet, which can be bent to suit any desired curve, and which is withdrawn as soon as the tip has entered the larynx.

The advantages claimed for this tube are: its cheapness and perfect simplicity; the ease with which it can be introduced and securely held within the trachea; the absence of danger to the tissues, owing to the fact that the tip, as well as the body of the tube, is made of soft, pliable rubber. A special advantage is that the tube passes through the larnyx and enters the trachea so that the reflex stimuli which are extraordinarily active in the laryngeal tissues are not excited to the same degree as when an intralaryngeal tube is introduced. For this reason the tube can be introduced when a patient is not under complete anæsthesia, as in the apparently drowned, in cases of opium or carbolic acid poisoning, or other profound narcotic poisoning with failure of respiration, and in asphyxia neonatorum.

The author has introduced the tube a number of times, in patients anæsthetized for various operations, and successfully maintained artificial respiration. In two cases the blood pressure was studied with a Stanton instrument, and no change in the arterial tension was noted during the time that the tube was in place. No opportunity has so far been offered for testing its value in operations on the intrathoracic organs.

Several experiments were made on cadavers

[1] Annals of Surgery, 1907, vol. xlvi, p. 544.

for the purpose of testing the practicability of the intratracheal tube for maintaining artificial respiration in emergency cases without the use of an air pump or any source of power other than the operator's lungs. No difficulty was experienced in producing rhythmical respiratory movements, and the expansion and contraction of the lungs as well as the movements of the thorax as a whole could be directly seen in the opened chest.

In one cadaver the lungs were filled with water by means of a syringe introduced into the trachea; the intratracheal tube was then inserted and the water drained off by gravity, after which the lungs were easily inflated by blowing into the tube. For greater ease of manipulation in emergency cases, especially for resuscitating the apparently drowned, an additional length of rubber tubing can be attached to the intratracheal tube by means of a glass connecting piece (Fig. 4). The tube is first introduced and the water drained from the lungs, after which the extra tubing, which the operator holds in his mouth, is attached and artificial respiration begun. Other modifications, such as a T-connecting piece with stopcocks, similar to the contrivance used in an aspirating set, naturally suggest themselves. With such a device an occluding false membrane in laryngeal diphtheria could be removed by aspiration, without danger of infection to the physician, as the stopcock leading to the mouthpiece could by turned off as soon as the exudate appeared in the glass connecting piece. In this way every physician would be equipped with a cheap and reliable instrument for emergency use in cases of diphtheria, even if he does not possess a set of intubation tubes and the technical skill to perform intubation or tracheotomy.

The author recently had an opportunity to test the intratracheal tube on an infant soon after death, and experienced no difficulty in entering the larynx. The lungs were inflated with ease and rhythmical respiratory movements maintained for some minutes by direct "mouth to trachea" insufflation.

Since writing the above I have used the canula in 3 cases of respiratory failure, with very satisfactory results.

EXPERIMENTAL PORTION

Technique used in animal experiments. In all experiments on animals the author makes it an invariable rule to administer morphin hypodermatically before placing the animal on the table, and to anæsthetize to the point of complete insensibility before beginning any experimental or operative procedures. In this way none of the animals experimented upon were allowed to suffer. The wound dressings are changed at short intervals, and the feeding is carefully attended to. All the animals used in these experiments seemed happy, with the exception of two, which became infected and were immediately killed.

In every case food was withheld for twenty-four hours before the operation. The hair over the area to be operated upon was removed by the application of a hot, saturated solution of sodium sulphid, or the field of operation was shaved with a razor, preference bring given to the use of an epilatory. The denuded area was scrubbed with soap and water, then with alcohol, and finally with a 1 to 2000 solution of bichlorid of mercury. The entire body of the animal, with exception of the area to be operated upon, was covered with sterile sheets. Three assistants were required. The surgeon and first assistant observed all the usual aseptic precautions, precisely as during operations on the human subject. The other two assistants, who were not required to sterilize their hands or otherwise adhere to the strict rules of asepsis, did not come into direct contact with the operative field.

The following instruments are required for this work: An artificial respiratory apparatus (see page 169), mouth-gag, knives, scissors, hæmostats, a Hays' saw, forceps, a clamp for the root of the lung, needles, and needle-holder. Cotton gloves are a necessity, as it is quite impossible to handle the lungs satisfactorily either with the bare hands or with rubber gloves; whereas covering the rubber gloves with gauze was found to obviate this difficulty. Cotton gloves were adopted as being more convenient than gauze. They are worn over the rubber gloves and frequently changed during the operation. In this way also blood clots can be removed from the pleural cavity with great ease.

The author experimented with a variety of clamps for controlling hæmorrhage and securely holding the lung tissue, but in every instance either the clamp would slip or the pressure required was so great that the lungs were permanently injured. Clamps with serrated edges, and clamps with fenestrations were tried, but proved unsatisfactory. The fenestrated clamps would not hold, and those armed with teeth tore through the lung tissue. The fingers, however, when covered with cotton gloves, act as admirable clamps and are preferable to any instrument for controlling hæmorrhage and fixing the lung tissue. On the other hand, it was found that a comparatively light clamp, with jaws protected by rubber tubing, could be applied to the root of the lung without doing any damage, and sufficient pressure used to control the hæmorrhage, if not absolutely, at least to a very great extent, the essential point being to limit the bleeding into the chest cavity as much as possible. For amputation of the

lung, clamps are a necessity. The clamps used in the author's work are shown in Figs. 1 and 10.

With regard to suture material, the same principles apply as in surgery of other parts of the body. Whenever it can be used, absorbable suture material is always best. In these experiments No. 0 plain catgut was used for the lung, and No. 1 chromicized catgut for the chest wall. Any ordinary surgical needles, according to the operator's choice, are suitable for closing the chest wound, while for suturing the lung tissue straight and curved round pointed needles are necessary.

SPECIAL POINTS STUDIED IN THE EXPERIMENTS

The questions which the author set himself to answer by means of these animal experiments may be summarized briefly as follows: 1. The influence of the healing process on the production of adhesions in penetrating wounds of the lungs. 2. The rôle of hæmothorax in the pathology of traumatic injuries, and its influence on treatment. 3. The technique of excision of lung tissue, of removal of an entire lobe, and of amputation of the lung. 4. The best method of controlling hæmorrhage and of preventing sloughing of lung tissue. 5. Methods of opening the chest cavity and closing the operative wound.

STAB WOUNDS OF THE CHEST

There were performed eighteen experimental stab wounds on dogs. These were made more or less at random, with the result that three wounds proved to be immediately fatal from injury of the heart, great vessels, and bronchi. Hæmothorax developed to a marked degree in seventeen of the eighteen cases; thirteen of these dogs lived and were killed by illuminating gas for autopsy. One dog died from injury to the heart; two from injury to the large bronchi and pulmonary artery; and two from bilateral pneumothorax, which the animals brought on by biting open the wound during the night. As these two dogs, however, lived for ten days after the operation before they reopened their wounds, it is fair to say that fifteen out of the eighteen animals operated upon survived the operation. In all of these cases the wounds were sutured, the toilet of the pleura performed, and the chest closed. Three of the dogs recovered without the formation of adhesions, and the wound or scar was almost invisible; seven dogs had very few adhesions; in the remaining five, adhesions were present to a very moderate extent. None of these animals became infected, and no empyema was observed.

Conclusions. These experiments prove conclusively that in every case of stab wound of the lung complicated by hæmothorax, it is advisable to perform thoracotomy, close the wound in the lung with sutures and, after attending to the toilet of the pleura, close the chest at once. With the ordinary technique outlined the results with this method of treatment are very satisfactory.

In a second series of experiments thoracotomy was performed, and incisions of the desired length and depth were made in the lung tissue; or all or part of a lobe was removed. This second series includes seventeen animals. In three dogs incised wounds were made in the lung and sutured; in one case a few adhesions resulted; the other two animals recovered without adhesions. This group should also include three experiments in which the animals died on account of failure of the Matas respiratory apparatus with Fell-O'Dwyer tubes (Nos. 2, 3, and 5).

In six dogs a portion of one lobe was removed. All of these made excellent recoveries, with the formation of only a few adhesions in some cases.

Of five dogs in which one lobe was removed, two recovered. One of the remaining dogs was perfectly well for ten days after the operation, but was either stolen or ran away, so that no autopsy was obtained. Two deaths were due to faulty technique in ligating instead of suturing the stump. As will be explained later, the remaining dog of this series died from infection of a superficial wound, and rupture of the resulting abscess into the pleural sac.

In three dogs the entire lung was amputated; one of these lived and the other two died. The failures are attributed partly to faulty technique in ligating instead of suturing the root. These three experiments were undertaken in the hope of throwing some light on the treatment of wounds of the large bronchi and blood-vessels, but the results obtained were disappointing.

Methods of opening the chest. The method of opening the chest in a dog is quite different from the same procedure in the human subject. In the dog thoracotomy is usually effected by making an incision parallel to the

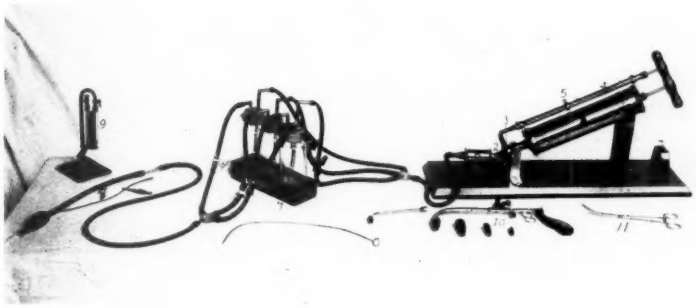

Fig. 1. Pump A. 1, intake; 2, exit; 3, cylinder; 4, piston rod; 5, thumb screw on piston rod; 6, filter box; 7, bottles for water and anæsthetic; 8, intratracheal pressure-bulb canula with bulb distended; 9, manometer; 10, Matas' modification of the Fell-O'Dwyer canula (note the different sizes of tips); 11, lung clamp.

ribs and separating and retracting the muscles down to and including the intercostals. The pleural cavity is opened by an incision between the ribs, and further exposed by separating the ribs with a rib spreader, which provides, plenty of room for operative procedures.

In the human subject this procedure is not applicable, and the surgeon has the choice of three methods of opening the chest: (1) the trapdoor method; (2) subperiosteal resection of the ribs; and (3) resection of the ribs and pleuræ en masse.

The first of these is the best, partly because it is quick and easy of performance, and partly because closure of the chest after the completion of the operation is more readily effected when this method is employed.

According to the author's experience, subperiosteal resection of a rib is difficult to carry out without injuring the pleura and its coverings (within the area of resection), which are almost certain to be torn during operation within the thorax to such a degree as to render perfect closure of the cavity impossible after the completion of the operation. The third method, resection of the ribs and pleuræ en masse, has the disadvantage that the portion of the framework of the chest included in the resection is not only temporarily but permanently lost. The edges of the pleura cannot be approximated, and the opening of the chest wall must be closed by apposition of the deep muscles. This method is always followed by the formation of adhesions. It is quick and short, but crude.

A trapdoor about five inches long and consisting of the sixth and seventh ribs, with the anterior margin of the door in the anterior axillary line, provides the greatest possible exposure and the readiest access to the parts to be operated upon. The ribs should be cut with a beveled edge in order to prevent sinking in of the trap. The pleura is then opened in the anterior axillary line, and two incisions carried backward in the fifth and seventh intercostal spaces respectively, for a distance of about five inches. This enables the operator to retract the trapdoor sufficiently for all nec-

Fig. 2. The author's intratracheal pressure-bulb canula. The upper photograph shows the canula with the stylet in place. The canula is ready for introduction. The lower photograph shows the canula with bulb distended and clamp in place.

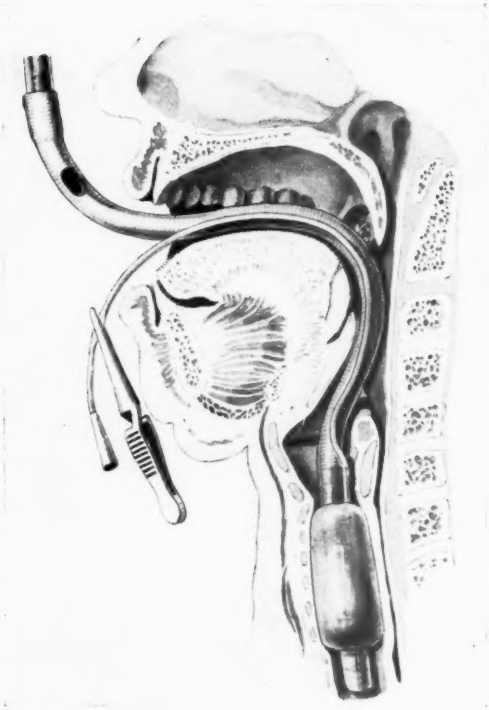

Fig. 3. The intratracheal canula in the correct position.

essary operative procedures without another division of the ribs, which would entail the danger of loss of blood supply to the trapdoor and adds to the difficulties of effecting perfect closure of the pleura. During operation the trapdoor is held open by means of a gauze strip used as a retractor, as shown in Fig. 7. Owing to the delicate structure of the membrane the pleura should not be sutured separately, as the sutures always tear out. The proper method is to include the pleura in the sutures through the intercostal muscles. The best suture for closing the pleural cavity is the "baseball stitch" applied from within outward with a round curved needle, which is introduced half an inch from the margin of the wound. The superficial muscles and fascia are then brought together, and the skin wound closed with a continuous suture. In this way three barriers are opposed to the entrance of air and infectious micro-organisms.

In the human subject the trapdoor is closed much in the same way; that is to say, the periosteum, pleura, and intercostal muscles are sutured together, and the superficial muscles united by a separate row of sutures with the muscles that form part of the trapdoor, thereby holding the latter in place, after which the skin wound is closed in the usual manner. It will be noticed that by observing this technique the cutaneous and the muscular lines of union do not directly overlie the pleural incision, and communication between the pleural cavity and the outside air is therefore avoided.

METHOD OF DEALING WITH INJURIES OF THE LUNG, WITH THE CHEST OPENED

As soon as the chest has been opened, the lungs and other intrathoracic organs must be carefully inspected; the wound, if there be any, located, and its nature determined along with any other complications that may be present.

In the case of wounds passing completely through the lung it is sufficient to close the wounds of entrance and exit with sutures, unless the injury is seated near the root of the lung, as in experiments No. 9 and No. 10. If a lobe is very badly torn or otherwise severely injured, or if the main trunk of the blood supply has been damaged, resection of the injured portion or of the entire lobe is a safer procedure. In the case of punctured wounds of the lungs the

Fig. 4. Intratracheal pressure-bulb canula in place with rubber tube and glass connection for mouth-to-trachea insufflation.

entrance and exit should be closed with sutures. For incised wounds the following method is recommended:

Method of suturing the lung. In his earlier experiments the author tried various methods recommended by different surgeons and finally selected the overhand method of suture, which is shown in Fig. 8. The needle in this method is inserted three-sixteenths of an inch from the margin of the wound and emerges at the deepest point in the incision; it then immediately disappears and again makes its final exit opposite the point of entrance three-sixteenths of an inch from the opposite margin. The suture is tied, and the same steps are repeated as in the case of a continuous suture, until the entire wound has been closed.

It was not found necessary to use Green's subpleural stitch to control hæmorrhage, because with the method just described hæmostasis was absolute. Apposition is perfect, provided the sutures are not drawn so tight as to cause eversion of the edges. By this method also the loss of tissue is less than with any other.

With regard to the continuous mattress, and the interlocking suture, it was found that they were more difficult to apply, apposition of the wound margins was less perfect, and more tissue was constricted. A continuous suture should be employed if possible, first, because of the economy of time; second, because hæmostasis is more complete; and finally, because less material is left behind to be absorbed.

Fig. 5. First step in subperiosteal resection of the ribs.

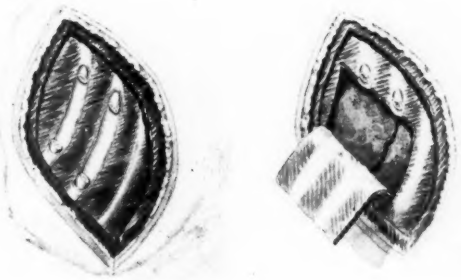

Fig. 6. Second and third steps in subperiosteal resection of ribs, showing flap completed.

Method of excising a portion of a lobe. This is shown in Fig. 9. After the lung has been exposed, an assistant takes firm hold of the viscus with the first and second fingers of one or both hands just behind the portion to be excised, using only sufficient pressure to hold the lung firmly and prevent hæmorrhage. A continuous overhand suture is used to close the wound in order to occlude any vessels or bronchi that may have been injured. Slight oozing from the needle holes is readily controlled by gentle pressure with gauze pads. When it occurs, the oozing is usually due to the use of the wrong kind of needle or catgut, or because the end of the catgut has not been bent over at the eye of the needle.

Method of excising the entire lobe. It is apparently a very simple matter to throw a ligature around the root of the lobe and remove the part. This is a crude method of procedure, however, and leaves a stump which is of necessity deprived of its blood supply, and therefore sloughs and eventually leads to a fatal infection. It must be remembered that the pleural cavity differs from the peritoneal in that there is no structure analogous to the omentum to cover up and protect the stump and assist in its absorption. Instead of simple ligation, the lobe must be excised about three-quarters of an inch from the root, leaving that amount of pulmonary tissue to be closed with the usual

Fig. 7. Drawing made from a cadaver, showing the trapdoor method of opening the chest and gauze retractor for holding the trap open.

overhand suture. If a large vein or artery is divided in removing the lobe, the vessel is first ligated with extremely fine catgut before the sutures are introduced. The root of the bronchus must be compressed with a small, light clamp when this method is employed, as the stump cannot be securely held with the fingers. By this method no stump is left behind to slough off, and no omentum is necessary.

Method of amputating the lung. The same method is recommended as that just described for excising an entire lobe. In two of the three experiments in which amputation of the lung was performed the old method of leaving a stump was employed, with the result that the wounds became infected and the animals died. In the third experiment, in which the above described suture method was employed, the animal lived a number of weeks and was finally killed for autopsy.

CLINICAL PORTION

For purposes of treatment, perforating wounds of the chest may be classified with reference to the presence or absence of hæmothorax, as this complication forms the pivotal point on which the choice of operative procedures hinges. In the early history of thoracic surgery it was a generally accepted axiom that an expectant, nihilistic treatment is always the safest. This course was undoubtedly wise in earlier times before asepsis had been developed, and even yet it must be regarded as the safest procedure in a large majority of cases, which includes chiefly cases that are not complicated by the development of hæmothorax. When, however, this complication exists, immediate operation is, in the author's opinion, advisable. The treatment generally followed at the present time consists in sealing the wounds of entrance and exit and immobilizing the injured side of the chest with adhesive plaster, at the same time combating inflammation and allaying pain as much as possible by the external application of cold in the form of an ice-bag or Leiter's coil and the internal exhibition of opium. If hæmorrhage develops, the pleural cavity is aspirated, the liquid portion of the

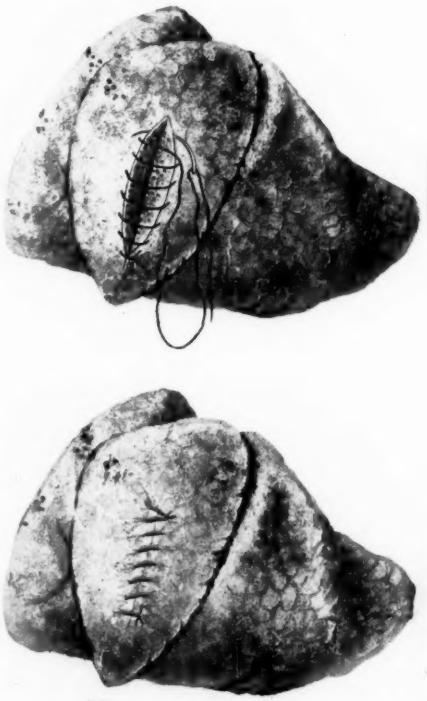

Fig. 8. The upper drawing shows the method of introducing the overhead suture. The lower shows the suture after it has been drawn tight and tied.

hæmatoma removed, and the wound sealed with an occlusive dressing — a procedure which may have to be repeated several times.

While this method of treatment rests on sound, conservative surgical principles, and is unquestionably the safest when none of the intrathoracic or abdominal viscera have been injured and there is no hæmothorax, with the danger of secondary infection, it is fraught with grave risks to the patient's life when these complications are present. In his operations on animals the author found it very difficult to remove even part of the blood clots with his hands, and quite impossible to remove any considerable portion of the hæmatoma by means of aspiration. The blood clots which must be left behind in the pleural cavity to be absorbed form a considerable mass, which interferes mechanically with the expansion of the lung, and in most cases becomes infected and leads to the production of empyema. This complication is a very serious one. It always causes retraction of the lung, frequently leaves a sinus, and may result in scoliosis of the vertebral column.

Fig. 9. Intercostal incision with the rib spreader in place, showing the method of holding the lung to prevent escape of air and to control hæmorrhage. Note the cotton glove on the hand.

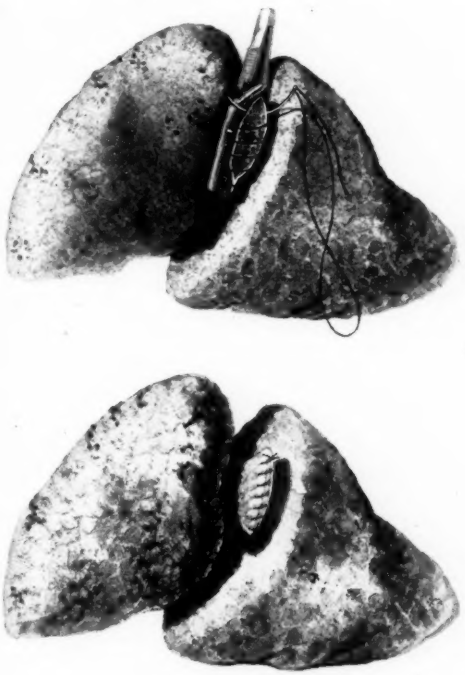

Fig. 10. Showing method of suture.

We may therefore consider the subject of perforating wounds of the chest under the following heads:

CLASSIFICATION

1. Perforating wounds of the chest *without* penetration of the lung:
   - *a.* Without hæmothorax.
   - *b.* With hæmothorax.

2. Perforating wounds of the chest *with* penetration of the lung:
   - *a.* Without hæmothorax.
   - *b.* With hæmothorax.

3. Perforating wounds of the lung without external solution of continuity, as by a fractured rib:
   - *a.* Without hæmothorax.
   - *b.* With hæmothorax.

4. Complications of perforating wounds of the chest:

a. Injuries to the heart and mediastinum.

b. Injuries to the internal mammary, and intercostal arteries.

c. Injuries to the diaphragm and abdominal organs (liver, spleen, stomach).

These groups again may be subdivided according as hæmothorax is or is not present.

The present investigation is concerned exclusively with lung surgery, and the author will therefore confine himself to the consideration of wounds of the lungs and pleuræ. From a clinical standpoint these may be again subdivided into stab wounds and gunshot wounds, although the pathology, symptoms, and treatment are practically identical in the two varieties of traumatism.

Stab wounds may be made with a sharp or a dull weapon or instrument, be it steel or other metal, wood, or possibly glass. In this type of cases the size and direction of the instrument should, if possible, be ascertained, as the surgeon has only the wound of entrance to guide him in his diagnosis of the extent of the injury.

In the author's animal experiments the dogs were stabbed with an amputating knife, without any attempt to control the direction of the instrument beyond its point of entrance in the fifth or sixth intercostal space in the anterior axillary line. In one case it was found that the lung had not been injured, the blade of the knife having lateralized itself and entered parallel to the chest wall.

Certain clinical peculiarities may be noted with regard to gunshot wounds, the chief of which is that there is usually both a wound of entrance and a wound of exit. Wounds produced by bird-shot are either so severe and extensive as to cause death before surgical aid can be obtained, or else so slight as barely to penetrate beyond the integumentary tissues.

TREATMENT OF PENETRATING WOUNDS OF THE LUNGS

The generally accepted method of treatment, as has already been stated, is purely expectant. It consists in sealing the wounds of entrance and exit and in applying an immobilizing dressing with cold externally and opium internally, as has already been explained. If hæmorrhage develops, aspiration of the pleural cavity to remove the liquid portion of the shed blood is usually advised.

While this expectant treatment is undoubtedly proper under ordinary conditions, there will always remain a number of cases with grave complicating injuries in which a more radical mode of procedure is imperatively indicated. Realizing this necessity, various surgeons have from time to time suggested and performed a number of different operations, of which the following are the most common:

1. Thoracotomy, to permit the entrance of air into the thoracic cage and favor collapse of the lung for the purpose of controlling hæmorrhage; mechanical removal of the clots, and closure of the wound with drainage.

2. Thoracotomy followed by fixation of the lung in the chest wound by means of sutures.

3. Thoracotomy and packing the pleural cavity with gauze.

The first of these methods is satisfactory so far as it goes; but it does not always control all the bleeding and is practically always followed by secondary infection, the formation of extensive adhesions, and limitation of pulmonary expansion on the injured side.

The second is objectionable partly because, like the first, it fails to control hæmorrhage, and partly because the shed blood and clots cannot be removed; and finally because it is accompanied by the formation of massive adhesions.

As to the third method, it must be characterized as bad surgery, and extremely dangerous. The pressure within the pleural cavity endangers the integrity of the heart and respiratory organs, and empyema with its many dangerous consequences invariably results.

The first and the third methods are both open to the objection that for several days after the injury only one lung is able to perform its function.

Author's method. The treatment recommended for perforating wounds of the lung is as follows: Rest in bed and expectant treatment during the first twenty-four hours, with the exhibition of small doses of morphin at

short intervals, just enough to keep the patient quiet. Constant and careful supervision of the patient, with frequent examinations in order to detect hæmothorax or any other complications at the earliest possible moment. If symptoms of hæmothorax or other complications do not develop within this time, expectant treatment may be continued for twenty-four hours longer, with such simple measures as the external application of cold and sedatives. The patient may then be allowed to rest in a sitting posture, and the treatment is continued for about ten days, after which he is allowed to get up and enters upon his convalescence.

On the other hand, if hæmothorax develops, the chest wall should be opened as soon as the diagnosis is made; all clots and serum removed; the wounds in the lung sutured; the pleural cavity inspected and its toilet completed; and the chest wall immediately closed, the lung being expanded by either negative or positive pressure. The suturing of the chest wall is effected by means of the layer method. With absolute asepsis and a faultless technique, especially in the matter of gentle handling, recovery without the formation of adhesions ought to take place in a large percentage of cases. The worst that can happen when this method is used is the formation of an empyema.

In the author's experimental operations upon dogs, above described, it is shown that in uncomplicated wounds of the lung attended with hæmothorax the animal invariably recovers.

Pleural adhesions have an important bearing on the prognosis of perforating wounds of the chest and help to explain the frequent occurrence of an unhoped for recovery in cases of severe injury to the chest wall. In the 100 cadavers which the author examined (see page 162) bilateral pleural adhesions were found in 27 per cent, and adhesions in one of the pleural cavities in 24 per cent (19 right and 5 left). In the presence of adhesions the traumatism is practically limited to the path of the bullet or knife point and the immediately adjacent lung tissue, so that a simple or direct penetrating wound of the lung results, without any possibility of pleural complications. The adhesions also prevent retraction of the injured lung and embarrassment of the heart, as well as of the opposite lung. Incidentally it would appear from the above table (page 162) that the prognosis of perforating wounds of the right side is better than that of similar injuries of the left side of the chest.

To sum up then: In the presence of hæmothorax the proper procedure is thoracotomy; mechanical removal of all clots and serum; closure of the lung wound by an overhand suture; and immediate closure of the chest wall, with the lungs expanded by either negative or positive pressure.

Perforating wounds of the lung without external solution of continuity. The same general principles in regard to expectant treatment apply to this group as to perforating wounds of the lung in general. With the development of hæmothorax the chest should be opened at the seat of injury by the flap method, blood clots and serum cleaned out, and the lacerated wound in the lung closed with catgut sutures in the usual manner. The surgeon then turns his attention to the cause of the puncture, which in the vast majority of cases is a fractured rib. The ragged end is excised for an inch or two; or, if possible, the fracture is reduced and the fragments are united with catgut sutures. After the toilet of the pleura has been attended to, the chest wound is closed in the manner already described.

Complications of perforating wounds of the right lung. a. Injuries of the heart. It is now a generally accepted surgical principle that wounds of the heart should be repaired at once by thoracotomy and suture, after which the lung injury receives the treatment described. Hæmothorax is of course always present.

b. Injury of the internal mammary or intercostal arteries. Hæmothorax developing from these complications should be treated as described, after the divided arteries have been ligated. The chest is closed without drainage.

Injury of the diaphragm and abdominal organs. These complications also necessitate thoracotomy. The injured abdominal viscus is drawn up into the thoracic cavity, repaired with sutures, if possible, as is also the wound in the diaphragm; and, after the pleural cavity has been thoroughly cleansed, the chest is closed without drainage. If the contents of any of the abdominal organs have entered the pleural cavity, it should be wiped out with

Murphy's solution of formalin and glycerine. In case the abdominal viscus cannot be repaired through the chest, or if the contents have soiled the peritoneum, the abdominal cavity must be opened, and the condition treated like any other perforating wound of the abdomen.

A wound of the chest should never be probed unless the area has been thoroughly sterilized and thoracotomy is to be immediately performed. The knowledge gained by probing is of little value and frequently quite misleading, while the procedure is practically always followed by infection.

ILLUSTRATIVE CASES

CASE 1. J. C., aged 30; white; male. Stab wound of the chest inflicted with a jackknife, the blade of which was four inches long and three-quarters of an inch wide. The direction in which the knife entered the chest could not be ascertained.

Examination. Perforating wound of the chest in the fourth intercostal space at the mid-clavicular line; a to-and-fro pleuritic friction sound was heard at this point. No râles or dullness obtained in any part of the chest. There was cough, but no expectoration; the patient complained of much pain at the seat of injury. The cough and physical signs of pleurisy continued for five days. No complications developed at any time, and recovery was uneventful.

Conclusions. In this case the knife-blade, in all probability, entered parallel to the chest wall without inflicting any injury on the lung.

CASE 2. A. C., aged 35; white; male. Was shot by a policeman with a 32 caliber revolver.

Examination. The wound of entrance was one inch below the sternoclavicular joint, and half an inch to the left of the sternum. It was impossible by inspection to determine the course of the bullet. There were signs of injury to the pleura at the right apex.

There was no cough or expectoration of blood on admission, and no symptoms or signs of hæmothorax developed at any time. Twenty-four hours after admission a slight hæmoptysis occurred and signs of traumatic pleurisy, made their appearance. The location of the bullet was determined by means of the X-rays below the center of the right scapula, making it apparent that the bullet had undoubtedly passed through the lung. As no complications developed the expectant treatment was pursued, and the patient was discharged cured.

Conclusions. Perforating wound of the lung without complications.

CASE 3. L. J.; aged 21; white; male. Self-inflicted bullet wound.

Examination. On admission a bullet wound was found in the fifth left intercostal space, one-half inch outside of the mid-clavicular line. The wound was surrounded by powder burns. A to-and-fro friction sound and numerous râles were heard, but there was no dullness on percussion. Expansion of the left chest was limited. The râles and the friction sound persisted for several days, but gradually diminished; as did also the cough, which was quite severe in the beginning. The bullet was located on the seventh rib posteriorly. Expectant treatment was used, and the patient was discharged cured.

Conclusions. Bullet wound of the chest with injury to the lung, but no other complications.

CASE 4. W. M.; aged 22; colored; male. Was shot at close range with a 32 caliber revolver. The patient was seen six hours after the injury and at that time presented cough, slight hæmoptysis, and pain in the right chest Temperature 98 degrees; pulse 160; respirations 40. The patient was conscious.

Examination. There were two wounds in the chest, one at the junction of the fifth rib with the sternum on the right side, and the other in the mid-axillary line and eighth intercostal space. A dark bloody discharge oozed from the axillary wound, and the surrounding area was swollen and œdematous. Numerous râles were heard over both sides of the chest. The heart and abdomen were normal, and there were no symptoms of injury to the diaphragm. The patient developed marked symptoms of a rapidly increasing internal hæmorrhage, and signs of hæmothorax were present in the right chest.

Operation. Under ether anæsthesia a subperiosteal resection was performed. The thoracic cavity was filled with dark blood in the process of coagulation. There were found to be four wounds of the lung, three of which were closed with sutures, and the blood clots removed; the fourth wound being slight and showing no signs of bleeding, it was not thought necessary to introduce sutures.

Advanced tuberculosis of the lungs was noted. Artificial respiration was carried on by means of Matas' apparatus without using the author's intratracheal tube. Respiration gradually became labored and the contractions of the heart increased in rapidity. As the pleural flap had been torn during the manipulations incident to the operation, it was necessary to close the chest merely by suturing the superficial muscles and skin. Death ensued from cardiac failure.

In this case operation should have been performed several hours sooner, thereby avoiding great loss of blood. It illustrates the danger of delaying operative interference, and also the inadequacy of the Fell-O'Dwyer tube in difficult cases.

PROTOCOL. EXPERIMENTAL WOUNDS OF THE LUNG

Experiment No. 1. Incised wound of the lung. May 11, 1909. Small, mongrel dog. Usual preparation and sterilization. Matas' apparatus in place with Fell-O'Dwyer attachment.

The chest was opened on the right side in the fourth interspace. The ribs were separated with the spreader and the chest inspected with the respiratory apparatus working perfectly. An incision two inches long was made in the middle lobe of the right lung. The wound bled profusely. A thin-bladed, rubber-covered clamp was then applied one inch behind the in-

cision, but was kept in place with difficulty. Finally the pressure on the lung necessary to keep the instrument in place became so great that it was removed, and the assistant, with gauze around his fingers, was able to hold the lung in the wound and control the hæmorrhage without difficulty. The wound in the lung was sutured with an overhand whip-stitch of No. 0 catgut. The toilet of the pleural cavity was made, and the chest wall closed in layers by the usual method.

The apparatus was discontinued and the dog breathed normally.

May 12, 1909. The animal is normal in every way; no pain; no physical signs except a few râles.

May 16, 1909. Dressing removed and wound cleansed. Dog in excellent condition.

June 21, 1909. Side entirely healed. At no time have there been any changes in the lung that could be detected by physical examination.

Autopsy. Left pleural cavity and lung normal. Right pleura healed with slight bulging from within outward at one part of the healed incision. The middle lobe of the right lung adherent along the outer side of the chest just above the incision. The adhesions were well developed, but did not prevent expansion of the lung. Other lobes normal. Plate A.

Experiment No. 2. Incised wound of the lung. Failure of apparatus. May 13, 1909. Medium size mongrel. Usual preparation and sterilization. Matas' apparatus in place, with Fell–O'Dwyer's attachment.

The chest was opened on the right side in the fourth interspace. As the dog breathed independently of the artificial respiration and the interpleural membrane bulged into the wound, the strokes of the air pump were adapted to the respiratory movements. There was no connection between the two pleural sacs, the chest being like the human in anatomical construction. The lung was drawn into the wound and incised for about one and one half inches. The margins of this incision were closed by a simple overhand suture of No. 00 catgut. A small quantity of blood, which had leaked from the incision into the pleural cavity, was sponged out.

At this time it was noted that the artificial respiratory apparatus had no effect upon the movements of the lung and that the abdomen was very much distended, showing that the tube of the apparatus was not in the larynx. Suddenly the intrapleural membrane ruptured and respiration ceased. An aspiration cup was placed over the external wound, but the suction exerted was not sufficient to maintain respiration, and the dog died from double pneumothorax.

Experiment No. 3. May 13, 1909. Medium size mongrel. Preparation of dog and apparatus as in experiment No. 1.

Through mismanagement of the apparatus and inability to keep the Fell-O'Dwyer canula in the larynx, the dog died immediately upon opening the chest of double pneumothorax, as there existed a communication between the pleural sacs.

Experiment No. 4. Incised wound of the lung. June 2, 1909. Large collie. Preparation of animal and apparatus as in experiment No 1.

Plate A. *Incised wound of the lung.* At *p* hernial bulging of the pleura into the chest wound. (Photograph: Exp. No. 1.)

The right chest was opened in the fifth interspace. The lung was incised one and one-half inches and the incision sutured with an overhand whip-stitch, the apparatus working perfectly. A small quantity of liquid blood was removed, and the pleural cavity wiped dry. The chest wall was closed in the usual manner with the lung distended.

June 17, 1909. Since operation the dog has been perfectly well. The dressings were removed on the fifth day; no suppuration was present. At no time have there been any abnormal physical signs except a few râles.

Autopsy. Chest opened and left pleural cavity found normal. In the right pleural cavity no adhesions were found. The wound in the lung had healed with the formation of a stellate scar. The lung was absolutely normal. The wound in the parietal pleura was found with some difficulty, showing that it had healed normally. Plate B.

Experiment No. 5. June 2, 1909. Small bulldog. The animal was etherized very deeply. When the Fell-O'Dwyer attachment was introduced and etherization continued through the tube, the dog suddenly died. Death in this case is attributable either to the excessive quantity of ether given in concentrated form, or to shock caused by manipulation of the larynx.

The experiment illustrates the difficulties attending the use of Fell-O'Dwyer's attachment, and first sug-

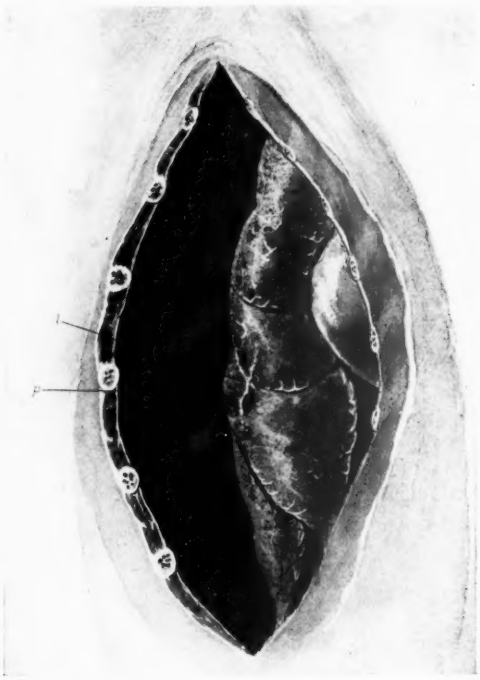

Plate B. *Incised wound of the lung.* The healed incisions in the lung and pleura are shown at *i* and *p* respectively. (Drawing: Exp. No. 4.)

gested to the author the necessity of a more practicable tube for artificial respiration with Matas' apparatus.

Experiment No. 6. Stab wound of the lung. June 11, 1909. Large, black collie. Preparation of animal and apparatus as in experiment No. 1.

A stab wound, four inches deep, was made in the fifth interspace and mid-clavicular line. Twenty minutes later the chest wall was opened in the fifth interspace. For a few minutes the dog breathed without the aid of the respiratory apparatus.

When the middle lobe of the right lung was drawn into the wound, it was found that the blade had entered about midway between the root and the margin. The entrance and exit wounds measured one and one-half inches. From both wounds the blood was pouring profusely. The lung was held in place by the gauze covered fingers of the assistant and both wounds closed with an overhand whip-stitch of No. 1 catgut. About one pint of clots and liquid blood was removed and the pleural cavity cleansed with gauze pads. The wound in the chest was closed by the usual method, with the lung distended. The dog left the table with labored breathing.

June 12. There was slightly diminished expansion on the right side, but a few râles and no dullness.

June 15. The wound was dressed and found in very good condition. Slight separation of the stitches.

June 22. *Autopsy.* The chest was opened and the pleural cavity was found normal. The cicatrix in the chest was slightly roughened and covered by epithelium, but otherwise normal. The wound in the lung was perfectly healed. No adhesions. Plate C.

Experiment No. 7. Stab wound of the lung. June 14, 1909. Large mongrel. Preparation of animal and apparatus as in experiment No. 1.

A stab wound was made in the right thorax with a large amputating knife, the blade reaching the posterior wall of the chest. After waiting thirty minutes, with respiratory apparatus working normally, the right chest was opened and the wound found in the center of the middle lobe. The wound was sutured with No. 0 catgut, and about eleven ounces of clots and liquid blood were removed. The pleural cavity was carefully sponged with gauze and the wound in the chest wall closed in the usual manner. The dog left the table in good condition.

June 16. When the wound was dressed four days later, it was found that several stitches had pulled out. The dressings were removed and the dog was allowed to take care of the wound.

June 22. *Autopsy.* The animal opened the healing wound with his teeth and died of the resulting double pneumothorax. The pleural cavity was found to communicate with an opening in the incision. The lung was expanded slightly. The pleural cavity showed a slight degree of inflammation, but contained no fluid. The wound in the lung was healed. Catgut showed no signs of absorption.

Experiment No. 8. Stab wound of the lung. June 14, 1909. Large mongrel. Preparation of animal and apparatus as in experiment No. 1.

The stab wound was made in the fifth interspace After waiting twenty minutes the chest was incised, and a through and through wound was discovered in the middle lobe.

This was sutured on the anterior and posterior surface with No. 00 catgut. A large quantity of blood had to be removed from the chest. Death occurred from respiratory paralysis, due to failure of the Fell-O'Dwyer canula.

This case again shows the difficulty of manipulation of the Fell-O'Dwyer attachment.

Experiment No. 9. Stab wound of the lung. June 16, 1909. Large collie. Preparation of animal and apparatus as in experiment No. 1.

The stab wound was made in the fifth interspace, the blade penetrating four inches. Two minutes afterward a hæmorrhage from the dog's mouth occurred and was accompanied by labored breathing. The Matas apparatus was rapidly put in place and artificial respiration started. The chest was opened by the flap method.

The right chest was found almost full of blood, and when the lung was drawn into the wound, it was found that a main pulmonary artery and a main bronchus of the middle lobe had been severed. This lobe was excised, but on account of the hæmorrhage into the bron-

chus and into the pleural cavities, it was impossible to resuscitate the dog.

Hæmorrhage in this case was the chief, but not the sole cause of death. The animal was practically drowned in its own blood, which entered the bronchus and was carried to the opposite, uninjured lung.

Experiment No. 10. *Stab wound of the lung.* June 16, 1909. Large bull bitch. Preparation of animal and apparatus as in experiment No. 1.

The stab wound was made in the fifth interspace about four inches in depth. Shortly afterward a hæmorrhage from the dog's mouth occurred and was accompanied by labored respiration. The Matas apparatus was rapidly put in operation and artificial respiration started. The chest was opened by the flap method.

The right chest was found almost full of blood, and when the lung was drawn into the wound, it was found that a main pulmonary artery and a main bronchus of the middle lobe had been severed. This lobe was excised, but on account of the hæmorrhage into the bronchus and into the pleural cavity it was impossible to resuscitate the dog, and he was drowned in his own blood.

Experiment No. 11. *Stab wound of the lung.* June 16, 1909. Large bull dog. Preparation of animal and apparatus as in experiment No. 1.

The stab wound was made in the fifth interspace. Twenty minutes afterward the chest was opened and the wound in the lung was found in the middle lobe. The wound was bleeding profusely and was sutured with an overhand whip-stitch. About a pint of blood was removed, and the chest was cleansed with gauze pads. The chest was closed in the usual manner.

June 24. The dressings were removed as the wound had healed perfectly.

July 6, 1909. *Autopsy.* No abnormal physical signs were present and the wound was perfectly healed.

The chest was opened and the left pleural cavity was found in a normal condition. The line of incision in the right pleural cavity was healed and a small portion of the middle lobe was adherent to it. The upper and lower lobes of the lung were normal in every way. Except for a few adhesions the middle lobe was normal.

Experiment No. 12. *Stab wound of the lung.* June 17, 1909. Small terrier, affected with mange. Preparation of animal and apparatus as in experiment No. 1.

The stab wound was made in the sixth interspace. After waiting some minutes the chest was opened and the lung drawn into the wound, in doing which the traumatism was still further increased. The incision was closed with an overhand whip-stitch, and when the suture was tightened, some puckering resulted. The clots and liquid blood were removed from the cavity and the chest wall closed by the usual method. The Matas apparatus worked perfectly during the entire operation.

June 24. The dressings were removed and the wound found in good condition, but the stitches were slightly pulled

July 6. *Autopsy.* The animal was perfectly well; no abnormal signs could be detected on physical examination.

Plate C. *Stab wound of the lung.* The scar is seen with difficulty at *l.* (Photograph of specimen preserved in formalin. Exp. No. 6.)

The left chest was normal, but the right lung with the exception of the lower lobe was adherent to the chest wall. The adhesions were most marked over the line of the incision, which was adherent to the middle lobe. Otherwise the dog was perfectly normal.

Experiment No. 13. *Stab wound of the lung.* June 21, 1909. Large mongrel. Preparation of animal and apparatus as in experiment No. 1.

A stab wound made in the fifth interspace. Collapse and symptoms of hæmorrhage immediately developed. The chest was opened by the flap method. The right pleural cavity was filled with blood, which was flowing from a wound in the right ventricle one and one-half inches long. The hæmorrhage was so profuse that suture of the heart was impossible.

A wound of this character must prove fatal in any case.

Experiment No. 14. *Stab wound of the lung.* June 21, 1909. Large mongrel. Preparation of animal and apparatus as in experiment No. 1.

A stab wound was made in the fifth interspace and, after waiting several minutes, the chest was opened and the injured lung sutured with No. 00 catgut. The wound was on the anterior surface and was one and one-half inches in length. The Matas apparatus did not work as well as in the preceding experiments, so another laryngeal tip of correct size was adjusted, after which the dog revived. This was very remarkable as the dog was apparently dead. The chest was closed in the usual manner, and the dog left the table in good condition.

June 29. The wound was dressed; but, as there was a slight separation of the edges, no stitches were removed.

July 5. *Autopsy.* There were no abnormal physical signs before the asphyxiation. The chest was opened and the left pleura was found to be normal. The right

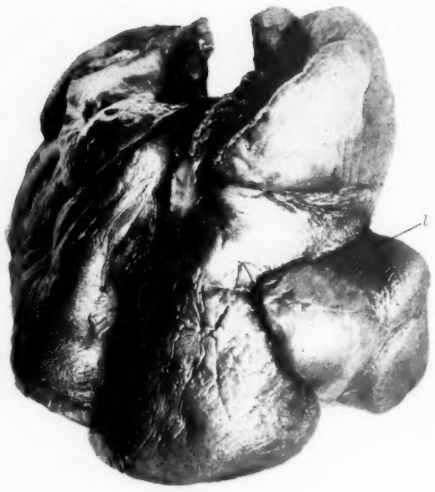

Plate D. *Stab wound of the chest.* The scar is seen at . (Photograph of specimen preserved in formalin. Exp. No. 15.)

lung and pleural cavity were normal, excepting for a few adhesions from the middle lobe to the line of the incision. The adhesions were quite dense.

Experiment No. 15. *Stab wound of the chest.* June 22, 1909. Mangy dog. Preparation of animal and apparatus as in experiment No. 1.

A stab wound was made in the sixth interspace, and after waiting twenty-one minutes the chest was opened, but no wound was found and the cavity was free from blood. A large piece of the middle lobe was then removed. The wound bled excessively and a clamp was applied. The pressure required to keep the clamp in place caused slight crushing of the pulmonary tissue. The hæmorrhage was controlled by a suture of No. oo catgut. As the bleeding still continued slightly, an extra suture was put in for absolute control. The blood was then removed from the cavity and the chest closed in the usual manner.

Autopsy. The dog was in good condition. The right chest had a few slight adhesions from the posterior surface of the chest wall and there were also a few adhesions between the middle lobe and the side of the chest.

A dark, slightly bluish ridge running across the middle lobe indicated the position of the clamp during the operation. In other respects the chest was normal. Expansion was practically normal. Plate D.

Experiment No. 16. *Stab wound of the lung.* June 24, 1909. Preparation of animal and apparatus as in experiment No. 1.

The stab wound was made in the fifth interspace and, after waiting fourteen minutes, the chest was opened. The blood and clots in the pleural cavity were removed. The middle lobe was then drawn into the outer wound and examined; the knife had punctured the middle lobe, making an anterior and a posterior wound about one inch in length. The anterior wound was closed with a mattress suture, which puckered instead of approximating the edges. The posterior wound was closed by an overhand whip-stitch with No. oo catgut; but, as the bleeding continued, slight pressure with gauze pads was applied. The pleural cavity was then cleansed with gauze pads and the incision closed in the usual manner.

July 14. *Autopsy.* The dog was perfectly well. No abnormal physical signs. The animal was killed by gas.

Left pleural cavity normal. Right pleural cavity normal, except for a few small adhesions from the posterior incision in the middle lobe to the lower end of the costal incision. Expansion of lung normal. Wound in the chest wall perfectly healed. Plate E.

Experiment No. 17. *Stab wound of the lung.* June 21, 1909. Large collie. Preparation of animal and apparatus as in experiment No. 1.

The stab wound was made in the fifth interspace and, after twenty minutes had elapsed, the chest was opened and the lung drawn out. The stab wound in the middle lobe was sutured with an overhand suture of No. oo catgut. The Matas apparatus worked perfectly.

July 14. *Autopsy.* Animal in good condition with no abnormal physical signs. Killed by gas. The left pleura and lung normal in every respect. Right pleural cavity and lung normal, with *no adhesions.* Wound in the lung was perfectly healed, as was the wound in the chest wall. Plate F.

Experiment No. 18. *Partial pneumonectomy.* June 25, 1909. Large spaniel. Preparation of animal and apparatus as in experiment No. 1.

Plate E. *Stab wound of the lung.* The scar is seen at *l.* (Photograph of specimen preserved in formalin. Exp. No. 16.)

The apparatus worked badly at first, insufficient etherization being the cause. When the dog was completely under the influence of the ether, the chest was opened at about the seventh interspace. The middle lobe was removed at a point three-quarters of an inch from the bronchus, after a clamp had been applied. The remaining portion of the right lung was then sutured with No. 0 catgut. No hæmorrhage occurred when the clamp was removed. A small amount of blood was removed from the pleural cavity with gauze pads. The chest was closed in the usual manner, some difficulty being experienced at the costal end of the flap. The dog left the table in good condition.

July 14. *Autopsy.* The dog was in good condition. There were no abnormal physical signs.

The left pleura and lung were normal in every respect. The right pleura and lung were also normal with *no adhesions*. The stump of the middle lobe was perfectly healed. The interpleural pressure was practically normal. Plate G.

Experiment No. 19. *Pneumonectomy.* June 28, 1909. Large collie. Preparation of animal and apparatus as in experiment No. 1.

The right chest was opened in the fifth interspace and the entire right lung amputated to within one-half an inch of the root.

The stump of each lobe was closed in the usual manner by an overhand whip-stitch. This suture gave perfect hæmostasis. During the removal of the lung and suturing of the stump, the hæmorrhage and the escape of the air from the stump were controlled by the use of the clamp shown in Fig. 1. After completing the toilet of the pleural cavity the chest was closed in the usual manner.

July 20. *Autopsy.* The dog ran up and down the corridor very rapidly and jumped about without apparent discomfort. There were no abnormal physical signs. The dog was killed by gas.

Plate F. *Stab wound of the lung.* Note the scar at *l*. The dark area at *a* is an artefact produced while removing specimen from the jar. (Photograph of specimen preserved in formalin. Exp. No. 17.)

Plate G. *Partial pneumonectomy.* The scar is barely visible at *l*. (Photograph of formalin specimen. Exp. No. 18.)

The incision in the left thorax showed the heart and interpleural membrane dislocated to the right side, with no evidence of enlargement or hypertrophy of the left lung, which was in a normal condition.

In the right pleural cavity the heart and interpleural membrane were attached to the right side of the chest by thin adhesions. There was no fluid present. The pleura was normal and the stump was perfectly healed.

Experiment No. 20. *Pneumonectomy.* June 28, 1909. Large mongrel. Preparation of animal and apparatus as in experiment No. 1.

The right chest was opened in the fifth interspace. The entire right lung was amputated and the root of each lobe ligated with chromic catgut. This ligature controlled the hæmorrhage perfectly. There was no interchange of air between the bronchus and the pleural cavity.

The chest was cleansed and closed in the usual manner.

Note.—It seems inadvisable to ligate the root of the lung en masse; a continuous suture introduced on the free surface of the bronchial stump is to be preferred. By this method no stump is left behind to slough and cause infection, all the pulmonary tissue that could possibly be infected is turned in and communication with the pleural cavity is avoided. Secondary hæmorrhage is less likely to occur as the strain is distributed and hæmostasis does not depend altogether on a single knot.

Autopsy. July 1, 1909.

The animal died July 1st, without apparently having suffered any pain since the operation. On opening the chest it was found that both pleural cavities contained a moderate quantity of dark liquid material

Plate H. *Stab wound of the lung.* The scar is seen at *l.* (Photograph of formalin specimen. Exp. No. 23.)

resembling a mixture of venous blood and pleural fluid. Upon inspection of the lung it was noted that there was a marked passive congestion. The root of the right lung was sloughing beyond the ligature, showing the inadvisability of ligating the stump. No communication between the bronchus and the pleural cavity was noted. A low grade of infection was present in both pleural cavities.

Experiment No. 21. *Stab wound of the lung.* June 28, 1909. Medium size mongrel. Preparation of animal and apparatus as in experiment No. 1.

Stab wound through the chest in the fifth interspace. After waiting twenty minutes, the right side of the chest was opened and the right pleural cavity found two-thirds full of liquid and clotted blood. The middle lobe was normal; this was replaced and the lower lobe brought into view. A wound extending from the anterior surface through the lung to the posterior surface was discovered. The wounds of entrance and exit were one inch in width and bleeding profusely. The anterior wound was closed with one through-and-through suture, which, however, did not control the hæmorrhage even after the pressure had been been applied for several minutes with gauze pads. This suture was then removed and the wound closed with an overhand suture, which controlled the hæmorrhage perfectly. The same treatment was applied to the posterior wound. A large quantity of clots and liquid blood was removed.

Owing to unskilful manipulation of the apparatus the dog became cyanotic and respiration stopped. The Fell-O'Dwyer canula was removed and a smaller laryngeal tip used. The canula was reintroduced after several minutes of entire absence of respiratory movements. The dog was apparently dead, but rapidly revived when the respiratory rhythm was re-established.

The cavity was cleansed and the wound closed in the usual manner. The dog left the table in good condition

Experiment No. 22. *Partial pneumonectomy.* June 29, 1909. Medium size mongrel. Preparation of animal and apparatus as in experiment No. 1.

The right chest was opened in the fifth interspace. The middle lobe was brought into the wound and a small thumb forceps placed on the root. This forceps controlled the hæmorrhage perfectly while the entire middle lobe was removed. The root of the lung was ligated en masse with No. 1 catgut. The forceps was then removed and the pleural cavity dried, after which the chest was closed in the usual manner.

July 6. *Autopsy.* Death was spontaneous.

The chest was opened an hour post-mortem and the left lung was found to be normal, with possibly a slight passive congestion. The right pleural cavity was also slightly congested. The lower margin of the upper lobes was attached to the chest wall near the line of incision. The chest wound was apparently normally healed. The stump of the lobe beyond the ligature was sloughing, again showing the inadvisability of ligating the stump in amputation of the lung.

Note.—This dog was apparently asphyxiated for about five minutes.

July 28. *Autopsy.* The dog was in good condition Killed by gas.

The left pleura and lung were absolutely normal. No adhesions were present and expansion was complete. The wounds in the right lung were perfectly healed.

Experiment No. 23. *Stab wound of the lung.* June 29, 1909. Medium size terrier. Preparation of animal and apparatus as in experiment No. 1.

The stab wound was made in the right side at the fifth interspace, the knife entering three and a quarter inches. After waiting twenty minutes, the chest was incised and the stab wound located in the middle lobe. Several ounces of clotted and liquid blood were removed. The wound was sutured with No. 0 catgut. The wound in the lung bled a trifle after the suture was introduced, but was controlled by pressure with gauze pads. The chest wall was then closed in the usual manner. The apparatus did not work as well as usual, probably because the tube in the larynx was not the right size.

July 20. *Autopsy.* The dog was perfectly well; exercising in a very lively manner. No abnormal signs were noted. The dog was killed by gas.

The left pleura and lung were normal. There were a few small adhesions from the posterior surface of the right lung to the chest wall, otherwise the chest was normal. The wound in the thoracic wall was per fectly healed. The lung was healed and expansion was normal. Plate H.

Experiment No. 24. Partial pneumonectomy. June 29, 1909 Medium size mongrel. Preparation of animal and apparatus as in experiment No. 1.

Excision of the entire middle lobe with ligation of the root of the lobe, as in experiment No. 22.

July 5. Through a mistake of the attendant the dog was removed immediately after death and no autopsy was held. This case, like experiment No. 22, would have shown the folly of ligating the root of the lobe.

Experiment No. 25. Stab wound of the lung. June 30, 1909 Large mongrel. Preparation of animal and apparatus as in experiment No. 1.

The dog was stabbed in the right side about the sixth interspace. The chest was opened and three small wounds were found and sutures with No. 0 catgut. Several ounces of clots and liquid blood were removed and the chest closed in the usual manner. The apparatus worked smoothly.

July 20. *Autopsy.* The dog was in excellent condition. No abnormal physical signs. Dog killed by gas.

The left pleura and lung were normal. The wound in the right lung was perfectly healed with only a few adhesions from the lung to the chest wall. The lung expansion was normal.

Experiment No. 26. Pneumonectomy. June 30, 1909. Large mongrel. Preparation of animal and apparatus as in experiment No. 1.

The right chest was opened in the fifth interspace. A clamp was applied to the root of the lung, and the lobes removed by ligating the root en masse. On removing the middle lobe a marked hæmorrhage occurred from breaking of the ligature. The toilet of the pleural cavity was performed and the chest wall closed in the usual manner.

The apparatus worked well and the dog left the table in good condition

The dog died July 3d.

Autopsy. The left lung contained numerous hæmorrhagic infarcts and interstitial emphysæma was present. The right pleural cavity contained four ounces of a dark colored liquid. The pleura was of a dark reddish color. The stumps of the lobes were all sloughing.

Experiment No. 27. Partial pneumonectomy. June 30, 1909. Small fox terrier. Preparation of animal and apparatus as in experiment No. 1.

The right chest was opened in the fifth interspace. A clamp was applied to the root of the middle lobe, and the outer half removed without hæmorrhage. The wound in the lung was closed by approximating the edges with an overhand suture. The clamp was removed and no hæmorrhage occurred. The toilet of the pleural cavity was performed and the chest wall was closed in the usual manner. No ill effects were noted from the clamp.

The dog was perfectly well two weeks after the operation, but disappeared during the night. No trace of the animal could be found. As he was perfectly well the day before, this case is counted as a cure.

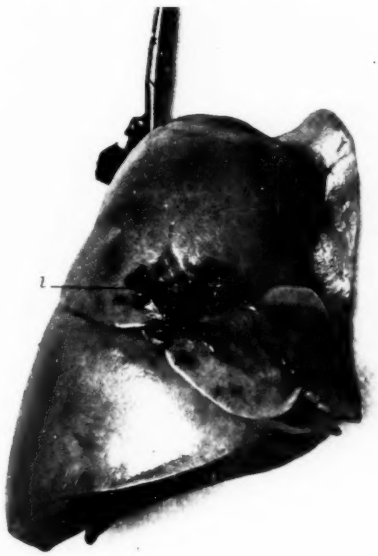

Plate I. *Partial pneumonectomy.* The scar is seen at *l*. The dark areas are adhesions and the results of the traumatism incident to removal of the lung from the chest cavity. (Photograph of fresh specimen. Exp. No. 37.)

Experiment No. 28. Partial pneumonectomy. July 1, 1909. Medium size mongrel. Preparation of animal and apparatus as in experiment No. 1.

The right chest was opened in the fifth interspace. A clamp was applied to the root of the middle lobe, and the outer half removed, without hæmorrhage. The wound in the lung was closed with No. 0 catgut by approximating the edges with an overhand suture. The clamp was removed and no hæmorrhage occurred. The toilet of the pleural cavity was performed and the chest closed by the layer method. No ill effects were noted from the clamp; the lung expanded perfectly after it was removed. The apparatus worked very well.

July 28, 1909. *Autopsy.* The dog is in good condition; no abnormal physical signs present.

The left lung and pleural cavity are normal. The right lung and pleura are normal, except for a few adhesions from the middle lobe to the chest wall. Expansion normal.

Experiment No. 29. Partial pneumonectomy. July 1, 1909 Medium size mongrel. Preparation of animal and apparatus as in experiment No. 1.

The right chest was opened in the fifth interspace. A clamp was applied to the root of the middle lobe, and the lobe removed at a point one-half inch from the root. The stump was sutured with a No. 0 catgut suture. Removal of the clamp was followed by oozing

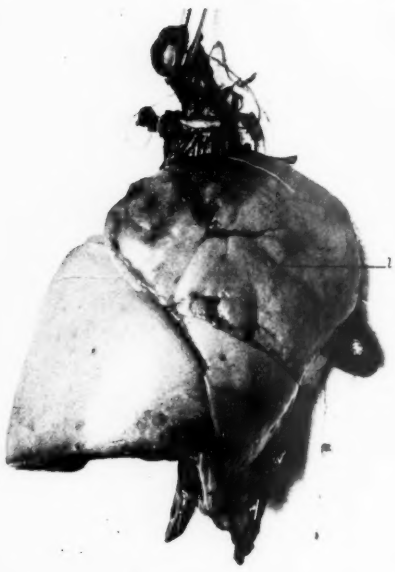

Plate J. *Incised wound of the lung.* The scar is not visible; the wound was at *l*. The dark coloration at the apex is due to collapse of the lung tissue just before the photograph was taken. (Photograph of fresh specimen. Exp. No. 38.)

of a few drops of blood, which was easily arrested by applying pressure with gauze pads. The toilet of the pleural cavity was performed and the chest closed by the layer method. The apparatus worked perfectly.

July 28. *Autopsy.* Dog in good condition; killed with gas.

Left pleura and lung normal. The right pleura and ung normal. Expansion full and complete. A very few adhesions.

Experiment No. 30. *Partial pneumonectomy.* July 1, 1909. Preparation of animal and apparatus as in experiment No. 1.

The right chest was opened in the sixth interspace. A large clamp was applied to the root of the middle lobe and the lobe removed three-fourths of an inch from the root. The stump was sutured with No. 0 catgut. The clamp was removed and no oozing occurred. The pleural cavity was dried and the chest was closed in the usual manner. The apparatus worked perfectly.

July 28. *Autopsy.* Dog in good condition; killed with gas.

The left lung and pleura were normal. The stump of the middle lung was entirely healed and fused with the upper lobe. A few adhesions were present. Expansion was normal.

Experiment No. 31. *Stab wound of the lung.* July 2, 1909. Preparation of animal and apparatus as in experiment No. 1.

The dog was stabbed in the sixth interspace.

Fifteen minutes afterward the chest was opened, and eleven ounces of clotted and liquid blood removed. The middle lobe had not been injured and was replaced after careful inspection. The lower lobe was then drawn into the wound and a bleeding incised wound discovered, which was sutured on the anterior and posterior surfaces. The posterior wound was bleeding profusely and continued to bleed for several minutes until sutured. The toilet of the pleural cavity was performed and the chest wall closed in the usual manner. The Fell-O'Dwyer canula was kept in place with difficulty. The dog left the table in good condition.

July 28. *Autopsy.* Dog in good condition and external wound perfectly healed. Killed with gas.

The left chest was entirely normal. The wound in the right lung was perfectly healed and discovered with difficulty. A few adhesions were present on the posterior surface of the lung. Expansion normal.

Experiment No. 32. *Stab wound of the lung.* July 2, 1909. Mongrel. Preparation of animal and appa ratus as in experiment No. 1.

A stab wound made in the sixth interspace. Fifteen minutes afterward the right chest was opened and found to contain about one pint of liquid and clotted blood. The middle lobe was normal. The lower lobe was pierced midway between the root and the lower border. Both wounds were bleeding and continued

Plate K. *Partial pneumonectomy.* The scar is invisible because covered with adhesions. (Photograph of fresh specimen. Exp. No. 39.)

to bleed profusely; but after suturing with number oo catgut the hæmorrhage was entirely arrested. The blood was removed and the toilet of the pleural cavity performed. The lung expanded and the chest wall was closed.

July 10. The dog seems perfectly well; expansion is full and unimpeded. The dressings were removed and the wound found to have perfectly healed by first in ention. No dressings were reapplied.

July 13, 1909. *Autopsy.* The dog was found dead in the morning, although perfectly well the night before.

The stitch in the chest wound had been partially pulled out, and the wound had opened into the pleural cavity. Both pleural cavities were normal. The wound in the lung was perfectly healed. A number of adhesions connected with the middle lobe to the posterior wall. This dog died from opening of the chest by pulling the sutures.

Note.—The dressings should have been replaced.

Experiment No. 33. *Stab wound of the lung.* July 2, 1909. Large bull terrier. Preparation of animal and apparatus as in experiment No. 1.

A stab wound was made in the sixth interspace. Sixteen minutes later the right chest was opened and found half full of liquid and clotted blood. The blood was removed, and a through-and-through wound was found in the lower lobe. The anterior and posterior wounds were sutured with No. o catgut controlling the hæmorrhage except for a slight oozing, which stopped on the application of pressure with gauze pads. The chest was closed with the lung distended. The artificial respiratory apparatus was not necessary as the animal had a complete interpleural membrane. When the apparatus was operated in unison with the normal respiratory movements it distended the right lung. In this way the lung was distended before closing the chest. The dog left the operating room in good condition.

July 22. *Autopsy.* The dog was perfectly well. No abnormal physical signs. Killed with gas.

The left pleura and lung were normal. The wounds in the right lung were entirely healed. A few adhesions from the lower lobe to the posterior surface of the chest were present. Expansion was full and unimpeded. The intrapleural membrane was intact.

Experiment No. 34. *Artificial respiration by air under continuous pressure.* October 2, 1909. Small mongrel.

Artificial respiration was maintained by passing air from the compressed air pipes in the laboratory through the series of bottles with which the Matas apparatus is equipped into a rubber tube inserted in the trachea. The tube was a No. 30 French catheter

Without aseptic technique both sides of the chest were opened by resecting a rib. The chest remained opened about twenty minutes, and during that time while air was being constantly forced in, the dog made only a few respiratory efforts. By regulating the amount of air pressure the degree of pulmonary expansion could be satisfactorily controlled. As soon as the left pleural cavity was closed by suturing the deep muscles respiration was at once re-established. The tube was removed before the right chest was closed. The dog recovered and walked around the operating room before he was killed.

Note.—The purpose of this experiment was to test the practicability of this method in human surgery; but it seemed to the author that the degree of pressure required to maintain satisfactory aeration of the blood by this method is too great for entire safety and jeopardizes the integrity of the pulmonary tissue.

Experiment No. 35. *Artificial respiration by Matas' apparatus and a simple rubber tube.* October 8, 1909. Medium size mongrel. The animal was prepared in the usual manner and a No. 34 F. woven catheter substituted in the Matas apparatus for the Fell-O'Dwyer canula.

With the above apparatus in place the right chest was opened and the outer third of the middle lobe removed. The wound was sutured with an overhand stitch as usual. With the Matas' pump working to its full capacity, the degree of pressure was not sufficient to maintain aeration, and the dog died.

Note.—Unless the return flow of air from the intralaryngeal tube is in some way prevented, the Matas apparatus will not carry enough air to the lungs.

Experiment No. 36. *Partial pneumonectomy.* Artificial respiration by Matas' apparatus and a simple rubber tube. October 15, 1909. Usual preparation and sterilization of animal. A No. 34 F. woven catheter was substituted in the Matas' apparatus for the Fell-O'Dwyer canula.

When the right chest was opened respiration ceased and the dog became cyanotic. The pump was then operated at the rate of about 40 strokes to the minute, and the outer portion of the middle lobe removed. The pleural cavity was dried and the chest closed in the usual manner. The operation had to be frequently interrupted and the wound plugged to allow the respiratory apparatus to work.

Conclusion. The Matas apparatus with a simple laryngeal tube, without a bulb, is not satisfactory.

November 8. *Autopsy.* The wound was in good condition. Expansion was good and there was no retraction of the chest wall. The left chest was normal and the wound in the lung was entirely healed. There were a few adhesions from the lung wound to the chest wall.

Experiment No. 37. *Partial pneumonectomy with intratracheal pressure-bulb canula.* October 11, 1909. Large mongrel.

Usual preparation and sterilization. Matas' apparatus with intratracheal pressure-bulb canula. The canula was easily introduced with the stylet in place the stylet removed, and the bulb inflated.

The right chest was opened and the outer third of the middle lobe removed and sutured in the usual manner. Apposition of the edges of the wound was not perfect, but the hæmostasis was nevertheless complete. The lung was held between the fingers of an assistant. The toilet of the pleura was made and the chest closed in the usual manner. The artificial respirations were twenty per minute. The pulse remained the same throughout the entire operation. The appara-

tus worked with the utmost simplicity and ease; nothing could be more satisfactory.

November 9. *Autopsy.* The dog was perfectly well. The left chest was normal, the right lung perfectly healed. The middle lobe was connected to the chest wound by a few adhesions. Plate I.

Experiment No. 38. *Incised wound of the lung.* Artificial respiration with the intratracheal pressure-bulb canula.

October 18, 1909. Large collie. Usual preparation and sterilization of animal. The intratracheal canula was introduced. The stylet was removed and the bulb inflated. The respirations could be heard and air felt at the outer end of the canula. The etherization was continued by covering the end of the canula with gauze soaked in ether. The apparatus was then connected and the pump worked at the rate of about twenty strokes a minute. The chest was opened in the fifth interspace and the middle lobe incised. The wound was sutured in the usual manner and the toilet of the pleura performed. The chest was closed and the bulb allowed to collapse so that the canula could be removed.

Note.—The apparatus worked perfectly, the pulse remaining unchanged during the entire operation.

November 8. *Autopsy.* Dog in good condition. No abnormal physical signs could be detected.

The left chest was normal. The wound in the right lung was healed and discovered with difficulty. There were no adhesions. The wound in the chest wall was perfectly healed. Plate J.

Experiment No. 39. *Partial pneumonectomy.* Artificial respiration with the intratracheal pressure-bulb canula. October 18, 1909. Large mongrel.

The intratracheal canula, with the stylet, was introduced and the bulb inflated. Respiratory sounds could be heard through the canula. The right chest was opened in the fifth interspace, and the outer third of the middle lobe removed. The wound was closed with an overhand suture which entirely controlled the hæmorrhage, but did not properly approximate the edges of the wound and an extra suture was applied. The lung was held in place by the assistant's fingers. The toliet of the pleural cavity was completed and the chest wall closed by the usual method.

Upon opening the chest the apparatus was started at 18 strokes to the minute and continued at this rate until the end of the operation. The pulse beat did not vary at any time.

Note.—The apparatus worked with absolute ease and perfection, though handled by two non-medical assistants who had never used the apparatus before.

November 8. *Autopsy.* Dog apparently normal. The left chest was normal in every respect. The wound in the middle lobe of the right lung was healed, but was connected to the chest wall by a few adhesions. Otherwise conditions were perfectly normal. Plate K.

Experiment No. 40. *Partial pneumonectomy.* Artificial respiration with the intratracheal pressure-bulb canula. October 18, 1909. Large mongrel.

The intratracheal canula, with the stylet, was introduced and the bulb inflated. Respiratory sounds could be heard through the canula. The right chest was opened in the fifth interspace and the entire upper lobe of the right lung was removed to within one-half inch of the root. The hæmorrhage was controlled by a light clamp, while the stump was sutured with an overhand whip-stitch. But as this did not entirely control the hæmorrhage, or make a perfect approximation of the edges, a second suture was employed. The toilet of the pleura was completed in the usual manner with the lung distended. After the chest was opened, the apparatus was worked at 18 strokes a minute and continued at this rate until the end of the operation. The pulse rate remained normal.

Note.—The apparatus worked with absolute ease and perfection.

October 20. Dog apparently well; eating normally.

October 25. *Autopsy.* The animal died.

Upon opening the skin incision a pocket of pus was found. The pus had ruptured into the pleura and caused an acute inflammation of the pleural cavity.

The stump of the upper lobe of the right lung was healing perfectly. The left lung and pleura were slightly congested. The infection in this case undoubtedly came from the chest wall and not from the pleura.

Experiment No. 41. *Artificial respiration with the intratracheal pressure-bulb canula.* November 8, 1909. Large mongrel, about to be killed for autopsy.

The intratracheal pressure-bulb canula was introduced, the stylet withdrawn, and the bulb inflated. The entire anterior wall of the chest was removed thus giving a direct view of the lungs and heart. The respiration was continued at the rate of 24 strokes a minute with the utmost ease. Even after this severe insult the rate and action of the heart did not vary to any perceptible degree. The dog's color did not vary. The artificial respiration was continued for fifteen minutes and, as this had proved the practicability of the apparatus, the pump was stopped and the dog allowed to die.

Experiment No. 42. *Artificial respiration with the intratracheal pressure-bulb canula.* November 8, 1909. Dog about to be killed for autopsy.

The intratracheal bulb canula was introduced, the stylet withdrawn, and the bulb inflated. The entire anterior wall of the chest was removed. The apparatus was started at the rate of 30 strokes a minute and maintained at this point during the entire operation. The dog's color did not vary. The degree of distension of the lung was controlled by varying the capacity of the pump. The artificial respiration was continued for fifteen minutes and, as this had proved the practicability of the apparatus, the pump was stopped and the dog allowed to die.

Experiment No. 43. *Artificial respiration with the pressure-bulb canula.* November 8, 1909. Large mongrel, about to be killed for autopsy.

The intratracheal pressure-bulb canula was introduced, and the bulb inflated. The apparatus was started at 28 strokes a minute and maintained at this rate during the operation. The entire chest wall was removed. The dog's color did not vary. The artificial respiration was kept for twenty minutes when the pump was stopped, and the dog allowed to die.

Experiments No. 44 and No. 45. These two experiments were conducted exactly like the preceding except that the pump was operated at the rate of 24 and 20 strokes per minute respectively. The results were equally satisfactory.

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LIVER ABSCESS [1]

IPECACUANHA IN THE TREATMENT OF THREATENED LIVER ABSCESS, FOLLOWING AMŒBIC DYSENTERY, AND IN OTHER BOWEL INFECTIONS

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ALTHOUGH the writer has been using ipecacuanha in the treatment of amœbic dysentery, bacillary dysentery, and diarrhœa, since 1899, his attention was first called to the influence of this drug in the prevention of threatened liver abscess by an article by Leonard Rogers in 1907.[2] Since this time the treatment has been thoroughly tried out in a large number of cases with surprisingly good results. In some of these cases the patients were suffering at the time with amœbic dysentery, complicated by hepatitis; some from hepatitis with a previous history of amœbic dysentery, but in these latter cases there were no dysenteric symptoms at the time, nor could amœbæ be demonstrated in the stools. Still other cases were treated in which there was no history of dysentery whatever and in which no amœbæ were found, and one case without a history of dysentery in which the stools were negative, but in which amœbæ were found after operation in the abscess cavity and in the stools. There were two cases of multiple abscess foci in the liver in which

[2] "The Early Diagnosis and Cure of the Pre-Suppurative Stage of Amœbic Hepatitis," volume 90, Royal Medico-Chirurgical Transactions, London.

[1] Read at the First Biennial Meeting of the "Far Eastern Association of Tropical Medicine" at Manila and Baguio, P. I., from March 5 to 14, 1910.

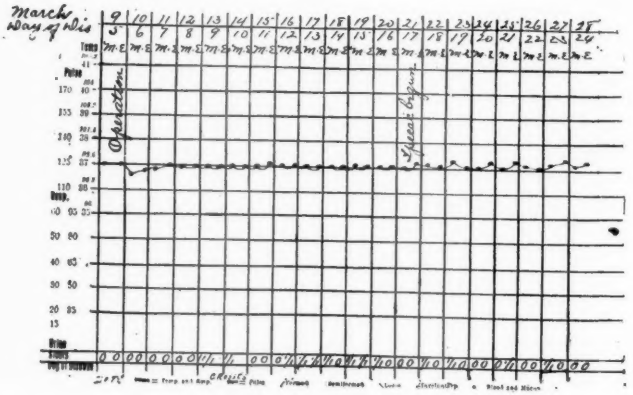
one or more were opened and drained by operation, followed shortly thereafter by symptoms of recurrence (the development-threatened or actual suppuration of new foci). These two latter cases yielded promptly to the ipecac treatment.

An outline history of a few of the cases treated, together with temperature charts, are herewith given:

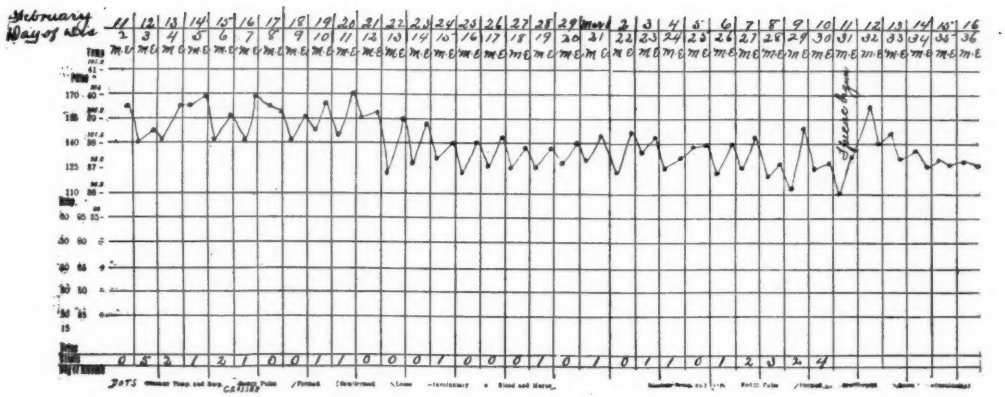
CASE 1. An American, 13 years resident in the tropics, aged 41 years, became ill March 5, 1907, complaining of pain in the region of the liver and right shoulder, indisposition, profuse perspiration, and anorexia. There was no history of dysentery. The liver was enlarged and painful to pressure. No malarial parasites were found. No amœbæ featured the stools. The urine was normal, the temperature normal throughout, and the white count, March 9th, 17,000. On March 9th, the liver was exposed and two abscesses in the right lobe evacuated, aggregating about 300 cc. of pus. Amœbæ were discovered in scrapings from the abscess wall and also in the stools on March 15th. Leucocyte count on this latter date registered 6,000. The patient did well until March 19th when all the symptoms returned and the leucocytes rose to 15,000. The ipecac treatment was begun on March 21st and gave prompt relief. On March 25th the leucocytes were 5,500. The patient was discharged well on March 30th and has remained so. An interesting point in connection with this case is its afebrile course. Chart 1.

CASE 2. A native, aged 24 years, became ill February 10, 1908. There was no history of dysentery. The bowels were usually constipated and the patient complained of slight, chilly sensations and fever. The liver was somewhat enlarged and tender to pressure over ninth and tenth ribs. Amœbæ were present in stools; the urine normal. No malarial parasites, and leucocytes, 11,000. The temperature ranged from normal to 40 degrees C. Ipecac treatment was begun on March 11th, after twenty-nine days of fever. The temperature reached normal on the fourteenth, after three days of treatment and so remained. The patient making a complete recovery, was discharged March 25th, and has remained well. Chart 2.

CASE 3. An American, male, aged 30, ten years resident in the Philippine Islands, first complained of fever and chills on July 27, 1908. I first saw patient on August 4th. He was very much reduced in flesh and strength and was having frequent profuse sweats. The temperature varied between normal and 39.6 degrees C. The temperature chart herewith submitted was, no doubt, considerably modified by pyramidon which had been frequently administered. The liver was considerably enlarged and painful on pressure and there was pain also in the right shoulder. There were occasional rigors preceding the sharp rises of temperature. No malarial parasites were found in the blood and several blood cultures proved negative. Leucocyte counts made on July 27th and August 1st were, respectively, 9,000 and 15,000. There was a history of amœbic dysentery some thirteen months previously which had apparently been cured by the colonic irrigation treatment. There were no amœbæ in the stools. The X-ray showed limited movement of the diaphragm on the right side. On August 4th, the leucocyte count was 28,000. Everything pointed so strongly to liver abscess that on August 5th, portions of both the eighth and ninth ribs were removed. The liver was found adherent to the diaphragm and anterior abdominal wall and quite œdematous but abscess formation could not be detected. Numerous aspirations with a specially constructed 18 cm. needle were negative for pus. The ipecac treatment was begun on August 7th, and there was a prompt change for the better. The patient was discharged cured August 28th and remains well at this writing. Special



Case 1



Case 2.

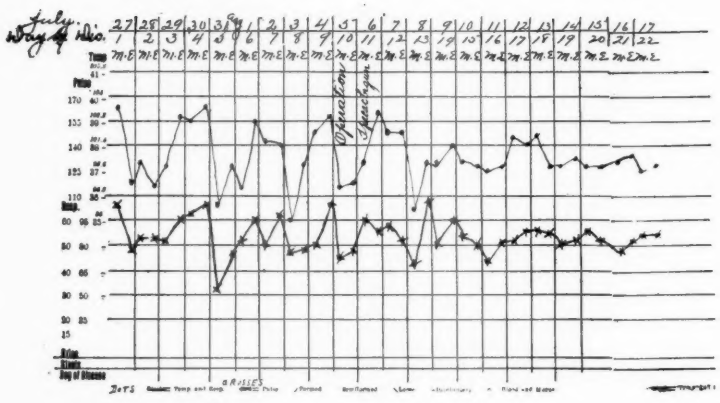
attention is called to the unusually high leucocyte count in this case. Chart 3 shows the temperature curve.

CASE 4. This case was that of an American aged 40 years, with 11 years' residence in tropics, ill since April 6, 1909, complaining of fever, chills and profuse sweats. There was no history of dysentery. The liver was slightly enlarged and tender to pressure. There were no malarial parasites, the urine normal, with no amœbæ in stools. The temperature varied from normal to 39.3 degrees C. The white count, April 28th, registered 10,000. Ipecac treatment was begun on April 29th with prompt relief of all symptoms. The patient was discharged May 13th cured and has remained well since. Chart 4.

CASE 5. European, male, aged 31, fifteen years resident in the Philippine Islands, taken ill with present trouble July 26, 1909, and first seen by me on the second of the following month. Had history of amœbic dysentery covering a period of six months. Colonic irrigations of quinine, tannic acid, and alphozone had been employed. The liver was slightly enlarged and a small painful tumor was palpable just below the costal margin, three cm. to the right of the median line. There was pain in the right shoulder. The temperature ranged from 37.0 degrees to 38.7 degrees C.; occasional slight rigors occurred; urine was normal; no malarial parasites and the leucocyte count 14,000. On August 3d an incision was made over the pointing abscess and 240 cc. of pus evacuated. Owing to adhesions between the liver and abdominal peritoneum the abdominal cavity was not opened. Scrapings from the necrotic abscess wall contained amœbæ. Temperature regained normal on the morning of the fifth and remained so until the evening of the sixth, when it reached 37.9 degrees C., with considerable pain about a point 3 cm. to the outer side of the opened abscess. The leucocyte count which had fallen to 10,000 on August 5th had now risen to 13,500. Ipecac was begun on the latter date. The temperature reached normal on the eleventh and so remained. See Chart 5.

CASE 6. A male, European, aged 34 years, eight years resident in the Philippine Islands, was taken ill with amœbic dysentery, June 20, 1909. When first seen by me, August 11th, the patient was very much emaciated and quite weak. There were from twenty to twenty-five bowel movements daily, consisting almost wholly of blood and mucus and containing large numbers of amœbæ. Leucocytes were 20,000. Differential count: Polymorphonuclear neutrophiles, 82; (eosinophiles, 0; transitionals, 2; large lymphocytes, 7; small lymphoctyes, 10 per cent. The urine was normal. The temperature flucutated between 37.5 degrees and 38.4 degrees C. The liver was moderately enlarged and tender to pressure. Limited movement of the diaphragm on the right was shown by the X-ray. There was pain in the right shoulder. The patient had been given colonic irrigations containing quinine, alphozone, tannic acid, etc., from the beginning. Several punctures of the liver with a long needle had been made through the chest wall without eliciting pus. The patient was put on the ipecac treatment August 11th and experienced prompt relief. There was a decided drop in the temperature on the thirteenth and relief from pain and on the fourteenth the temperature reached normal. The patient was now able to sleep which he had not been able to do for weeks; the stools gradually diminished in frequency; the blood and mucus cleared up, and the appetite returned. The leucocytes in this case dropped very gradually, reaching normal in about ten days. The patient was practically well early in September. Amœbæ had disappeared from the stools which were now perfectly normal in appearance. He was discharged August 30th, and has since remained well. See Chart 6.

It is not believed that the ipecac treatment of dysentery holds the place it deserves among the



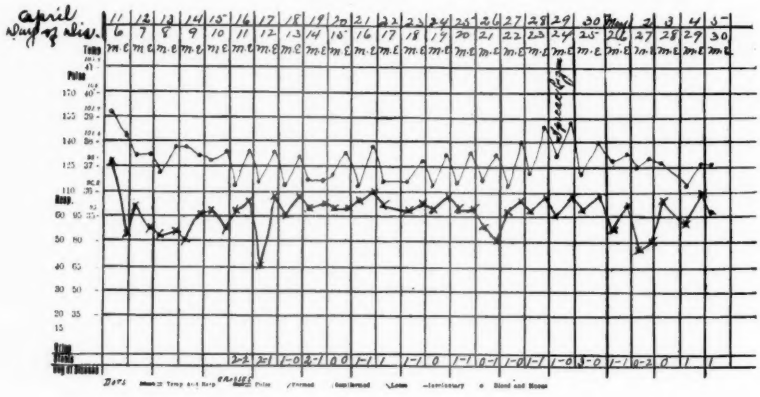
Case 3.

American physicians in civil practice in the Philippine Islands. I have treated several hundred cases of amœbic dysentery since my arrival in the Islands, in 1899 (both while in the medical corps of the army and since in private practice), by both the colonic irrigation treatment and the ipecac method, and have found the latter treatment to be more prompt and sure in its effects. I do not know of a single case of liver abscess complicating amœbic dysentery where the ipecac treatment was instituted early in the disease and properly carried out. In all of the cases of liver abscess which have come to the writer for operation there had been either no treatment at all or they had been treated by the administration of other drugs than ipecac or by colonic irrigations or both. In the irrigations such drugs as quinine, alphozone and tannic acid were most commonly employed.

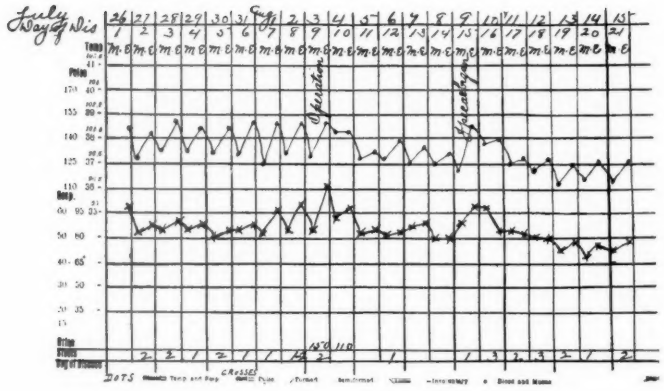
The ipecac treatment of amœbic dysentery has been very largely employed from an early date of American occupation at the United States Military Division Hospital, Manila, with pronounced success.

The ipecac treatment is prompt and efficient. If instituted at an early stage, the patient does not have to be confined to home or hospital for more than five or six days and the treatment seldom needs to be repeated unless there has been a reinfection.

The time required to take two colonic irri-



Case 4.

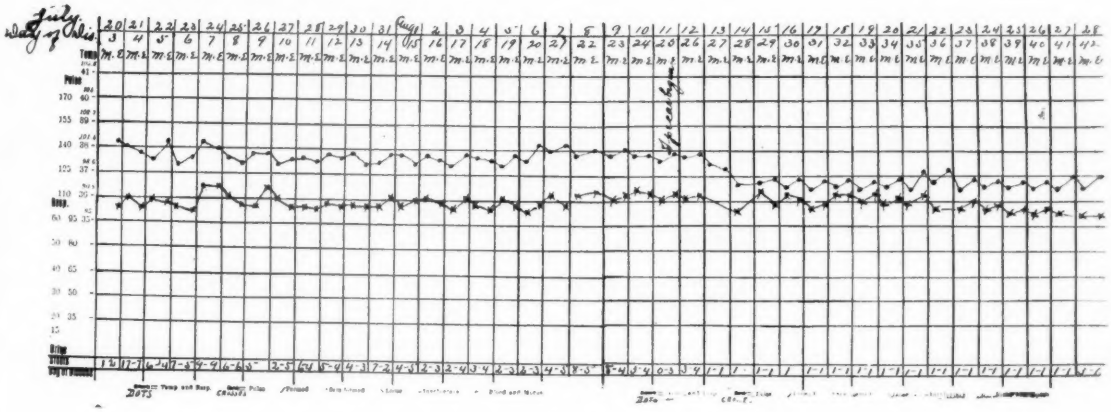


Case 5.

gations a day is considerable. They are accompanied by more or less soreness or irritation about the anus owing to the frequent passage of the tube, and the colicky pains due to distension of the bowel is intense in some cases. On account of the inconvenience, discomfort, and pain, the patient often refuses to take treatment at all. In hæmorrhoids, its administration is impossible. These treatments to be successful at all must be carried out at least six weeks to two or three months, and the writer knows of many cases where the irrigations have been taken for over a year with amœbæ still present in the stools.

It is a mechanical impossibility for the fluid to reach all the parts of the affected mucosa at each irrigation which it must do to effect a cure promptly or at all. When colonic irrigations are used a short tube not more than nine to thirteen cm. in length should be used. The farce of using the long tube with the idea of carrying the fluid to all parts of the colon has been well illustrated by means of the X-ray by Horace W. Soper, of St. Louis, Mo.[1]

Dr. Soper quotes a number of well known authorities in support of his position and in closing his paper says: "In conclusion, I believe it is only in those rare cases of abnormal development of the sigmoid that it is possible to introduce a soft rubber tube higher than six



Case 6.

[1] "The Colon Tube and the High Enema," Journal of the American Medical Association, August 7, 1909, pp. 426–428, vol. liii.

or seven inches in the rectum without it bending or coiling on itself. With the aid of the sigmoidoscope only the middle of the sigmoid can be reached. The practice of allowing liquid to flow through simultaneously with the introduction of the tube serves to smooth out the kinks and adds to the illusion that the tube is going higher."

The method of administration of ipecacuanha, with some important modifications, is that described by Manson.[1] A preliminary dose of castor oil and laudanum is given and the patient put on a milk diet. After fasting for four hours from both food and water, two grams of ipecac are given, in six pills, with just as little water as possible. The patient must lie on his back in bed in a dark room, and should not be allowed to talk or be in any way molested. He should take no food or liquid for eight hours after taking the medicine. After the eight hours are up the patient may take milk and water liberally until four hours before the time for the next dose. I usually have the patient fast from 4 P. M. and give the pills at eight o'clock P. M. In this way he may take his food during a good part of the day. If the pills are so made that they will pass out of the stomach without dissolving, the preliminary dose of tincture of opium and the mustard plaster to the stomach may be dispensed with without fear of nausea. If at any time nausea should occur, an ice bag about the throat gives most relief.

Grams 1.650 are given on the second day; 1.325 on the third; 1.0 on the fourth; 0.650 on the fifth, and 0.325 on the sixth day. The patient is now put on light diet and a 0.325 GM pill given for six days longer when cure is usually complete, although in some cases it may be necesssary to continue for twelve days.

[1] "Tropical Diseases," 1907 edition, p. 452.

In this method of administration the making of the pills is a very important matter. The pill mass is best made with the extract of glycyrrhiza. The pills are then coated heavily with salol or enclosed in kreatinized capsules. They may be coated with salol in quantities by rocking in a warm mortar with a little melted salol, or if only a few are needed, they may be fixed on a needle and dipped in the melted salol.

If kreatinized capsules be not at hand the pill mass may be put in the ordinary gelatin capsules and the space between cover and body of the capsule sealed with a little liquid gelatin. The capsules are then placed in a Petri dish and a few drops of formalin are put in the dish so as not to touch the capsules. The cover is then placed on and allowed to remain for about eight hours. The capsules should be exposed to the air for six or eight hours before use as otherwise they will prove irritating to the stomach.

This method of treatment has proved of value in the catarrhal, bacillary, amœbic, and balantidium forms of dysentery and in diarrhœa so frequently met with in this country.

We should not lose sight of the fact that dysentery and diarrhœa were treated with some considerable degree of success by means of ipecac and simaruba in the hands of the Spanish and native physicians for many years before the advent of American occupation.

The powdered bark and especially a decoction made from the bark of simaruba, in large doses, as given by the Spanish and native physicians, is one of the most valuable remedies we have to-day for subacute and chronic dysentery.

Much could be said on the ipecac treatment of amœbic dysentery, but this subject is not within the scope of this paper.

BONE-GRAFTING AND OSTEOPLASTY[1]

A Case of the Latter Presented

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BONE-GRAFTING may be defined as the art of transplanting living bone from the same individual, from a different individual, or from an animal, to another bone or periosteum for the purpose of repair, or restoration of function.

Other materials such as bone-chips, calcined bone, decalcified bone, bone-ferrules, bone-plates, dead bone, or living bone when deprived of its periosteum and endosteum, are not properly termed bone-grafts. They serve merely as arbors or trellis, over which the real bone may grow in the process of repair, or otherwise act as irritants to provoke the osteoplastic process.

Does the living graft remain as such and grow or does it excite new bone-formation and disappear forever from the stage of activity? This question is undecided. That the center of the graft dies while the periphery becomes fused with the living bone and continues its identity, is the opinion of some. As a general proposition, such a conclusion is not justified by the facts. In some cases it is doubtless true that the periphery survives at the expense of the center; in others, both periphery and center survive; while in others still neither survives as such, having served coequally only in the formation of fibrous tissue — often of the greatest service.

The subject of bone-grafting has been touched upon in different terms to express much the same purpose, since in addition to bone-grafting, we read of bone-implantation, of bone-transplantation, and of bone-regeneration. The button of bone returned to its site after a simple craniotomy or trephining is regarded as a bone implantation. Pirogoff's osteoplastic amputation is designedly a bone-transplantation.

Calcined bone, an approximate physiological substitute for bone, since it supplies the lime salts, readily fills cavities until it is replaced by bone, which latter grows over and through its interstices like the vine upon the arbor. Such a method illustrates artificial bone repair or regeneration. Because of the strength of the resultant bone tissue, calcined bone is perhaps better than decalcified bone.

In the compound or comminuted fracture with considerable loss of fragments, in malunion following loss of bone, in long bones with considerable loss of continuity of the shaft, in dislocations and fracture dislocations, in gunshot wounds with shattering of the bone, in deformities and osteomyelitis, in ankylosis and pseudoarthrosis, and especially as a substitute for amputation — bone-grafting finds its chief utility.

Bone-grafts are of numerous kinds, as witness: 1st, the animal bone attached to recipient while adherent by periosteum, soft structures, and vascular supply, to an adjacent part of the donor's body; 2d, a portion of human bone attached by periosteum, soft structures, and vascular supply, to an adjacent portion of the donor's body, as in facial fractures and deformities; 3d, detached live bone of an animal donor implanted into defect of human recipient; 4th, a detached live bone of the human donor, his own or that of another, implanted into defect of the recipient.

In a long bone whose center has been destroyed but whose periosteal tube is intact, one can, by means of the osteotome or chisel, chip off pieces from the ends of the broken bone, pack them in the periosteal tube connecting the proximal and distal fragments, and with reasonable confidence look forward to bony union of the shaft. Even in the absence of the periosteal tube the case is not hopeless, for an artificial tube can be made of the soft parts, filled in with bone-chips and held in position by chromic catgut sutures.

Some prefer human, some animal grafts; both are successful. The ready availability

[1] Read before the Medical Society of the District of Columbia, March 30, 1910.

Fig. 1. View of moulded stump taken after the operation; patella in position, fixed by screws buried beneath fibro-periosteum and penetrating only dense bone. Patient can now (three months after operation) stand his weight upon the firmly united patella. (Radiographed by Dr. T. A. Groover.)

of bone-grafts from the lower animals to man, and their successful application, warrant the assumption that this field of usefulness will shortly be greatly augmented.

Opportunity presenting, the osteoplastic offers the best as well as the safest method of repair.

To Philip Francis von Walther, in 1813, is due the distinction of having been the great pioneer in osteoplastic surgery. He has had many disciples since his day, most honored among whom may be mentioned Ollier, Pirogoff, Sabanejeff, Gritti, and Bier.

In the osteoplastic method the freshened surfaces of bone are variously held in contact — the bone surfaces may be held in apposition when there is no strong counterpull by simply suturing the surrounding soft parts together; the periosteal edges may be sutured together; or the surfaces otherwise held by screws, wires, pegs, or nails.

In the long bones the osteoplastic operation admits of closure and protection of the medullary canal, secures a solid end of bone to meet pressure, avoids adhesions between sawed bone and soft coverings, and by retaining mobility of the parts, lessens the dangers of neuralgia and stump ulceration.

Having touched upon bone-grafting and osteoplasty in general. let us for a moment glance at a case [1] of the latter in particular:

H. M., male, aged 22, single, laborer; previous history, negative; present history: He was brought to the Emergency Hospital November 14, 1909, having just sustained a gunshot wound of right leg at the lower end of the middle third. The firearm was a 16-gauge shotgun, choked bore, carrying 3 drams of powder, 1½ ounces of No. 6 shot, held and accidentally discharged by its owner, standing close by patient's right side. The line of shot was oblique, from right to left, directed downward and inward.

Examination showed a ragged, perforating wound, one and one-half inches wide, two inches long; destroyed musculature; posterior tibial and peroneal arteries severed; four inches of fibula shattered and completely destroyed; tibia and anterior tibial artery intact.

Immediate operation consisted of removal of blood clot, and bony fragments; curettage of soft parts for all obtainable shot and destroyed tissue; bichloride, followed by normal salt solution, irrigation; drainage tubes; one-half of one per cent carbolic acid wet dressing; the administration of 1,500 units of antitetanic serum; local warmth, and rectal instillation of normal salt solution to maintain vigor of circulation. From the first saving the limb looked hopeless, but the patient declined amputation, and there was an attempt to observe his wishes.

On the evening of the 17th, gangrene present; amputation was urged, the patient being plainly told that the responsibility would rest altogether upon himself otherwise. With temperature 104°, pulse 140, and respiration 44, on the morning of the 18th he consented to amputation, when a disarticulation was done at the knee, the long, broad-curved anterior and short-curved posterior flaps being used; patella retained. On the 19th, temperature, pulse, respiration, registered 99.6°, 88, and 20, respectively.

On December 10th a portion of the flap sloughed, however, the result of the gangrenous process, exposing the joint, which likewise showed an initial necrosis. Additional amputation being necessary, this, with an osteoplastic grafting of patella, was decided upon, and performed December 11th.

The technique of the operation was as follows: Edges of old skin flaps trimmed to healthy tissue and

[1] For this patient the author is indebted to Dr. W. P. Carr.

skin dissected circularly, the cuff turned back above the saw line; soft structures dissected free from the bone three and one-half inches above the articulation where the dimensions of the femur are at one with those of the patella; femur amputated; posterior soft structures carefully trimmed with scissors into a broad concavity for reception of the anterior, broadly curved convexity of ligamentum patellæ and capsule; patella turned back upon thigh, articular surface upward, and held firmly in a piece of muslin by assistant while it was sawed in half horizontally; it was then turned upon itself, brought down and fitted into exact position upon the end of femur, held immovably by assistant; at opposite sides of the bone near its periphery the periosteal elevator was used to peel to either side the fibroperiosteum for access to the bone with a countersink the size of the screwhead used; with countersink of the selected size a depresssion was made into which the bone drill was fitted, the diameter of bone drill being a trifle smaller than that of the screws employed; holes were then drilled through patella and into the dense bone of the femoral ring to a depth nearly corresponding to the length of the screws; following the bone drill came the bone threader, whose thread corresponded with those of the screw; one inch iron screws were then driven home by means of a screwdriver, the heads of the screws lying a trifle below the external surface of the bone; the fibroperiosteum was then returned to position, sutured over the heads of the buried screws with oo chromic catgut; chromic catgut No. 2 was then used for suturing the inferior concavity of soft parts to the superior convexity, consisting of fibroperiosteal capsule and ligamentum patellæ; the skin flaps were then brought over all, sutured with interrupted silkworm gut, reinforced by plain No. 1 catgut and rubber drainage tubes placed, one passing through all structures to the saw line, the other just beneath the skin, and left in position for two days out of abundant precaution.

The patient has made an uneventful recovery. The patella is firmly united. After three months he is able to stand his entire weight upon the stump without pain.

It may be well to recall that Gritti divided the femoral condyles at the level of the adductor magnus tubercle, applied the sawed patella to the sawed femur, and covered the stump with a long rectangular anterior flap. Stokes's modification advances Gritti's femoral saw line three-quarters of an inch above the tubercle. In neither is bone sutured to bone, while the operation herewith presented carries the saw line $3\frac{1}{2}$ inches above the articulation to a point where the transverse section of femur corresponds with the size of the split patella, permitting of the most exact coaptation. The higher amputation not only approximates bone sections of similar size but prevents dangerous tension as well, while still affording ample leverage. The bones are fixed with screws, removable at will and within five minutes if desirable. The stump is useful, its end is not irritable. The scar is removed from pressure and designed for present-day prosthetic apparatus. Better than transverse section, uncovered though smooth, it has no corners or osteophytic outgrowths to make pressure upon a sensitive scar. And instead of the bone end being very sensitive it is insensitive and extremely serviceable. The scar is subject neither to pressure nor to traction, with a resultant minimum of disturbance. The result is a reproduction of the *status ante quo*, for the anterior surface of the patella — a natural pressure bearer — is preserved, together with the bursa between the skin and itself, leaving the latter undisturbed. One's weight can be as steadily borne as when one ordinarily kneels, its length is sufficient to permit leverage within the socket of a most serviceable artificial limb, upon which the patient can walk as if upon his own leg.

This suggests a thought upon the subject of amputations, for next to the saving of life, the chief object of amputation is a useful stump. What then are the requisites of a useful stump? Ample covering, musculo-periosteal if possible, firmness in consistency, insensitiveness, minimum sacrifice of healthy tissue, small wound area, good blood supply, favorably placed cicatrix, efficient drainage, absence of tension of soft parts over bone, adjustability of artificial limb, largest range of adaptability, regularity and symmetry in contour.

Judged by these standards, the author submits that the method here adopted has this in its favor, that from the ashes of this or that quibble in technique arises the great question of service to humanity, and before us would appear to be a stump not only painless upon pressure but one of everyday, practical usefulness as well.

A DECEPTIVE FORM OF APPENDICITIS IN WOMEN[1]

By H. S. CROSSEN, M. D., St. Louis, Missouri
Professor of Clinical Gynecology, Washington University

THERE is an unusual form of appendicitis that proves very deceptive when occurring in women, for the reason that in its clinical characteristics it so closely resembles adnexal disease. The mass is situated in the tubo-ovarian region, and furthermore the mass develops so gradually and with so little acute disturbance that it is suggestive of a new growth rather than inflammation. These deceptive features are fully accounted for by the pathological changes found at operation. The exact pathological condition is not clear, however, when first exposed, for the mass seems to be *within* the cæcum and involving its walls. The cæcum with the contained mass is movable and may be picked up and palpated between the examining fingers, and gives the impression of a new growth or other intracæcal mass extending from the ileocæcal valve to the lowest part of the cæcum. The appendix is nowhere visible.

Within the last thirteen months I have had two cases of this character and both cases came under my care with a diagnosis of tumor (new growth), presumably adnexal. In each case the mass, when exposed and directly palpated, was suggestive of a serious lesion of the cæcum and ileocæcal junction, possibly requiring extirpation of the cæcum. The two cases were practically identical in their peculiar features, and they are good examples of a distinct class, that is very interesting when considered from the standpoint of diagnosis or from the standpoint of treatment.

Case 1. Mrs. S., aged 39, seen in December, 1908, in consultation with Dr. D. E. Schmalhorst and Dr. Hudson Talbot of St. Louis. The patient was a widow, the mother of three children, the oldest eleven and the youngest seven years of age. No particular trouble during confinements. General health previously good, with the exception of some pelvic dragging and weakness, since the birth of the children, and a tendency to indigestion. In the spring and summer of 1908 the patient noticed a gradually increasing disturbance of her health. There were no acute symptoms but she could not stand exertion as formerly and would have to rest in the afternoons. The pressure and indefinite distress in the pelvis and lower abdomen became more marked, though there were no distinct pains. In September, 1908, the patient noticed a lump in the right lower abdomen. It was not particularly painful and she did not consult a physician, thinking that perhaps it was some disturbance that would pass away. This lump remained and increased in size slowly. There were no other special developments for a period of three months, at the end of which time she had her first acute, or rather subacute, attack. The day before Thanksgiving, 1908, the patient was shopping and walked a great deal. She felt unusually tired and weak and there was some soreness through the pelvis and lower abdomen, but no sharp pain. After reaching home, however, she noticed severe pain in the region of the lump, and was obliged to go to bed. Within a few days she felt better and began to get about, but in a week from the first attack she had a second and more severe attack of pain in the same region. Dr. Schmalhorst was called, recognized a serious condition in the right ovarian region, and called Dr. Talbot in consultation. The advisability of operation was apparent and the patient was sent to the hospital, where I was asked to see her in consultation. On examination, I found a mass in right tubo-ovarian region the size of a small orange, flattened, firm, somewhat tender and fairly movable. The patient was a thin subject who relaxed the walls well and permitted thorough bimanual examination of the pelvis. The appendix region was clear of trouble. The mass was exactly in the ovarian region and there seemed no doubt but that it was ovarian or tubal in origin. This opinion, as to the mass being adnexal and not appendical, was held by Dr. Schmalhorst, Dr. Talbot, and myself. As to whether the mass was a new growth or inflammatory in character, there was some difference of opinion and no decisive evidence either way. The patient's temperature was normal (temp. 98.6, pulse 76, resp. 20), and she had had no fever at any time as far as could be determined. The mass was partially movable and did not present as much tenderness as was to be expected with an inflammatory mass of that size. All these facts pointed to the mass being a new growth, and that was the opinion held by Dr. Schmalhorst and Dr. Talbot, both of whom had given the case careful investigation.

The main features of the case certainly justified the diagnosis of a new growth of gradual development with the recent onset of subacute irritative symptoms. For myself, I could not reach a positive conclusion on that point,

[1] Read before the Western Surgical and Gynecological Association at Omaha, December 21, 1909.

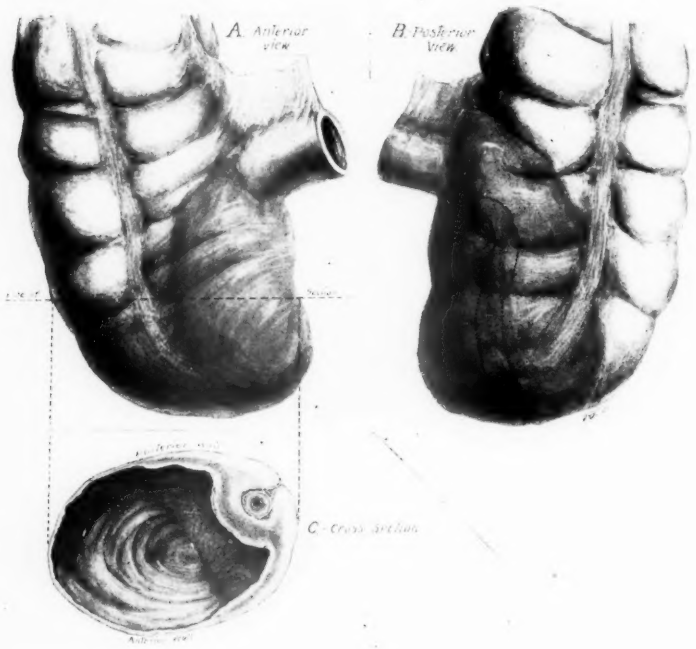
from the somewhat irregular shape and partial fixation and moderate tenderness and absence of clear borders, I was inclined to think it a chronic inflammatory mass. We all agreed that the mass was undoubtedly adnexal.

When I opened the abdomen, the right side of the pelvis was found occupied by the cæcum, and in the cæcum and about the ileocæcal valve was the mass. The cæcum had been displaced downward until it occupied the ovarian region. The appendix region, about McBurney's point, was clear of trouble. Under the displaced cæcum lay the right tube and ovary, practically normal. By breaking up a few adhesions I was able to raise the cæcum so as to palpate the mass between the fingers behind and the thumb in front. It seemed to be situated in the wall of the cæcum and occupied the inner half and extended from the lowest part to somewhat above the ileocæcal junction (Fig. 1, A). The mass was firm and felt as though the cæcal wall at the affected part were many times as thick as it should be. From the feel of it as I held the cæcum between my fingers, it might have been a carcinoma arising about the ileocæcal valve or tuberculosis of the cæcum or the chronic ulceration that occasionally produces much serious trouble in this region, requiring excision of the cæcum. There were no obstructive features and the ileum was normal. The appendix was nowhere to be seen, the guide band of longitudinal fibers ending apparently in the cæcal wall (Fig. 1, B).

As the mass seemed to be in the cæcal wall, it was thought that possibly it would be necessary to excise the cæcum. Having had experience, however, with the eccentricities of the appendix in certain cases, I determined to find the appendix before proceeding, both to have it for a landmark and especially to be absolutely certain that the trouble did not come from it. After considerable search, I was able to make a line of cleavage at the end of the guide band. Following this cleavage I came to the base of the appendix, and then following the line of cleavage farther and separating the cæcal wall, which had folded over the appendix and become adherent, I was able to expose the appendix throughout its whole length. The appendix and adjacent cæcal wall were greatly thickened. This thickening of the cæcal wall was apparently due to chronic infiltration caused by the adjacent appendix inflammation. It was most marked immediately about the inflamed appendix and shaded gradually into the surrounding tissues (Fig. 1, C). The appendix was retrocæcal and its tip lay in the neighborhood of the ileocæcal junction (Fig. 1, B). No pus was found, but in enucleating the thickened and friable appendix from its bed it was torn and a small enterolith escaped. After the appendix had been removed, a large part of the mass still remained, being due to thickening in the cæcal wall. I felt certain, however, that the thickening was not a primary disease of the wall but merely inflammatory infiltration from the appendical inflammation. The infiltrated tissues were very friable and it was with difficulty that I could get sutures to hold sufficiently. The infiltration was extensive and the inflammation chronic and of low grade. There was no evidence of its being tubercular. I brought a small drain out of a stab wound in the side and closed the median wound completely. Microscopic examination of the removed tissue showed no tuberculosis nor malignancy — simply chronic inflammation.

The patient convalesced without particular incident except that a considerable mass remained in the cæcal region for a long time. Two examinations have been made since the patient left the hospital. The first, three months after the operation, showed a considerable mass still present in the cæcal wall. The last examination was made a short time ago about eleven months after the operation. The infiltration had almost disappeared. There is still a slight thickening below McBurney's point. It is movable and apparently is the remains of the infiltration in the cæcal wall. The patient feels well, there is no special tenderness, and, save for the slight thickening, nothing remains of the previous trouble.

CASE 2. Mrs. H., aged 35, seen in May, 1909. The patient was the mother of three children, the oldest nine and the youngest three years. General health previously good and no particular local disturbance. In November, 1908, patient began to feel badly. There was a dragging sensation and indefinite distress through the pelvis and lower abdomen and pain in the right thigh. The trouble increased gradually but



without acute symptoms until the latter part of April, 1909, when she became much worse. During the next two weeks she suffered almost constant pain in the right lower abdomen and pelvis but kept up and at work. A physician who was called in, found a mass in the right ovarian region and made a diagnosis of tumor.

I saw the patient two weeks after the onset of distinct localizing symptoms. She was still trying to do her work, but was scarcely able to drag about the house. Complained of constant pain in the region of the mass. Examination showed very much the same features as those mentioned in the first case. In this second case, however, the process was apparently more severe. The general health was affected more, the pain in the mass was more constant and severe, there was more tenderness, there was some fever (temp. 101) and the mass was larger, occupying the ovarian region and extending to the appendix region. The history was not distinctive of either tubal trouble or appendicitis. The facts ascertained by abdominal and pelvic examination were not positive either way, but from the situation of the mass I would have made a diagnosis of tubal inflammation had I not remembered the experience of the previous case. As it was, I put it down as probably tubal, possibly appendical.

When I opened the abdomen, I found very much the same peculiarities as in the first case. The cæcum was displaced downward and occupied the right ovarian region. There were adhesions limiting the mobility of the cæcum, which accounted for the fact that in the examination the mass could not be displaced appreciably from the tubo-ovarian region. When the adhesions were separated it was found that the mass was in the cæcum and not in the tube or ovary. The mass involved the inner and posterior portion of the cæcum and extended up about the ileocæcal junction. The appendix could nowhere be seen. After persistent endeavor, however, a line of cleavage was opened where I felt that the appendix ought to be. A little further progress into this cæcal mass revealed the appendix, greatly thickened and surrounded by the inflamed cæcal wall which enveloped it. The thickened appendix was enucleated and at its tip was found a small perforation abscess, containing not more than a teaspoonful of pus and well walled in. Drainage was established through a separate wound in the side and the median incision was closed completely.

The patient had a stormy convalescence, the temperature going as high as 102.8° in spite of free drainage. After a few days, however, the temperature gradually subsided and eventually the patient made a good recovery. When the patient left the hospital there was still quite a mass, which I considered as due largely to the greatly thickened cæcal wall. An examination recently (five months after the operation) showed that

the infiltration had practically disappeared. No mass nor induration could be felt, there was no particular tenderness, and no local symptoms. In this case, where pus was present, the infiltration disappeared much more rapidly than in the first case, in which no pus was found.

The special points to which I wish to call attention in connection with these cases are as follows:

1. The *location* of the mass in the tubo-ovarian region instead of in the appendix region. In the first case, palpation about McBurney's point showed no trouble there, and in the second case, simply the edge of the mass extended to the appendix region.

2. The *scarcity* of inflammatory symptoms. Each patient was sick for several months and quite a mass had formed before any acute symptoms appeared, and even when they did appear they were comparatively mild. So marked was this feature that the mass, in connection with the history, gave the impression of a new growth, and it was with that diagnosis that each patient came under my care. This is accounted for in a measure by the extreme chronicity of the inflammation and also by its inclusion in the cæcal wall, as explained in the next paragraph.

3. The *apparent intracæcal character* of the mass. This was a striking feature and was due to the folding of the cæcal wall about the chronically inflamed appendix (Fig. 1, C). Because of the special relation of the appendix to the cæcum, or because of the chronicity of the low grade inflammation, or both, the infiltration and adhesions affected principally the wall of the cæcum adjacent to the inflamed appendix. The hidden appendix was not hidden by adhesions binding the cæcum to the posterior abdominal wall, for the cæcum and mass were movable and could be lifted about freely after a few pelvic adhesions were broken. Neither was it hidden by being retroperitoneal. Microscopic examination of the appendix showed that it had its regular peritoneal covering, practically encircling it, hence it was not retroperitoneal. The appendix was hidden by being buried in the overlapped cæcal wall. This is what made it so difficult to locate and expose the appendix, and it was this also which gave the sensation of a mass within the cæcum.

This peculiarity is important from the standpoint of treatment for, unless carefully investigated, such a condition might be treated by extirpation of the cæcum, under the mistaken supposition that the mass was a tumor of the cæcum. This peculiarity helps to account also for the dislocation of the mass. As the cæcum with its contained mass was movable, it naturally dropped downward into the tubo-ovarian region. Later, adhesions formed fixing it in that abnormal location. Evidently the cæcum in this type of cases is more than ordinarily movable, the unusual mobility being due to the high reflection of the peritoneum on the posterior wall of the cæcum. Kelly states that this high reflection of the peritoneum is found in eight per cent of bodies, and he mentions that in such cases the cæcum is apt to hang far down into the pelvis. This complete envelopment of the cæcum by peritoneum also favors the extensive infolding of the wall as here found.

4. The *slow absorption* of the infiltration in the cæcal wall, after the removal of the affected appendix. In the first case, absorption of the infiltration in the wall of the cæcum required nearly a year. In the second case, in which pus was found, the absorption of the infiltration was more quickly accomplished, requiring only about five months. Fortunately, in both women, the abdominal wall was thin and permitted of deep palpation, consequently the diminution of the cæcal induration could be accurately followed. Both patients recovered completely.

In designating this condition as a "deceptive form of appendicitis in women," I do not mean to imply that it does not occur in men, but only that it is especially deceptive when it occurs in women. As to its relative frequency, I can not speak with certainty. No doubt it has been encountered by several of the surgeons present, but the condition is practically unmentioned in the literature that has come to my notice, though I have not had the time for an exhaustive search.

I feel that attention should be directed to this class of appendicitis cases because of the difficulties in differtenial diagnosis (principally in women) and also because of the difficulties in recognizing the true pathological condition

after the abdomen is open. The apparent absence of the appendix may prove very confusing. In discussing these two cases, Dr. Hurdon, of Baltimore, related to me the following instructive incident. In the museum of one of the large eastern institutions was a mounted cæcum labeled "Absence of the Appendix." Obtaining permission to dissect the specimen, Dr. Hurdon found just the condition here described, i. e., the appendix was buried in the overlapped and adherent cæcal wall. So completely was it buried that it had been missed entirely by the physician who presented the specimen and by those who had since examined the same.

The fact that the apparent intracæcal character of the mass may lead to a mistaken diagnosis of cæcal tumor, is pointedly illustrated by the following case, which was related to me by Dr. A. Edward Meisenbach, of St. Louis, who witnessed the operation. The patient, a man, was subjected to operation for trouble in the right lower abdomen. A mass was found which was supposed to be a malignant tumor of the cæcum, and accordingly the cæcum was removed. Following the resection the patient developed peritonitis and died. Subsequent examination of the removed mass revealed the fact that there was no malignant disease, but instead the condition described in the two cases here reported, i. e., an inflamed appendix buried in the overlapped cæcal wall.

DEPARTMENT OF TECHNIQUE

CLOSING INCISIONS IN THE RENAL PELVIS

By HOWARD A. KELLY, M. D., Baltimore, Maryland

I HAVE for some years past been in the habit of utilizing, in closing the renal pelvis, the lamella of Gerota's fascia (fatty capsule) which spreads out over the posterior surface of the kidney as well as its pelvis. The tissue of the pelvis *per se* affords no satisfactory secure hold for sutures closing an incision made, say, in extracting a calculus, but when this fibrous capsule is caught and sutured as an additional layer overlying the pelvis proper the whole is bound securely together and such a wound rarely leaks.

I had looked forward to presenting this matter in my forthcoming book on the Surgery of the Kidney, but my good friend, Dr. William J. Mayo, has anticipated me and deservedly secures priority, having with his usual surgical acumen also discovered this important secret in the surgery of the the renal pelvis some years ago. It only remains for me to add to his clear and satisfactory description such small additional memoranda as seem to be important. I would again observe that this structure is a definite anatomical one, being a part and a continuation of the fibrous capsule which is penetrated by the finger in exposing the kidney through the loin.

I would note, too, this important point, namely, that in incising the pelvis of the kidney, I take care to disturb and displace this fascial layer as little as possible so that on closing the incision the fascia simply lies ready to be drawn over the wound in the pelvis from the adjacent sides. I avoid, if possible, any extensive detachment.

Another valuable use of this fascial layer is in plication of the hydronephrotic pelvis. It is here the firm hold for the needle is secured in passing from the margin of the kidney where the fascia is unusually strong down towards the ureter and back again to the margin in the form of the letter V. See also Fig. 2 for a valuable use made of it in restraining a moderately distended renal pelvis.

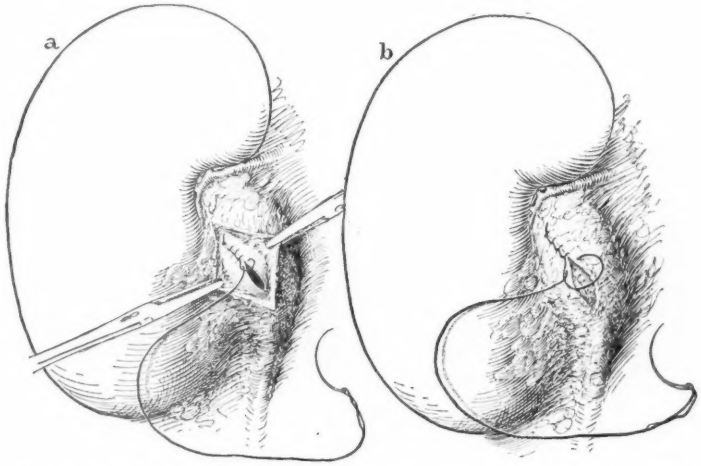


Fig. 1. *a*, Pelvis of a kidney which has been laid open for the extraction of a stone, half closed with a running locking suture of chromacized gut. The fascial layer spoken of in the text is the one drawn aside by the forceps *b*, Chromacized gut or fine black silk suture closing the fascial layer over the line of suturing in the renal pelvis proper. This fascial layer is a little too distinctly defined.

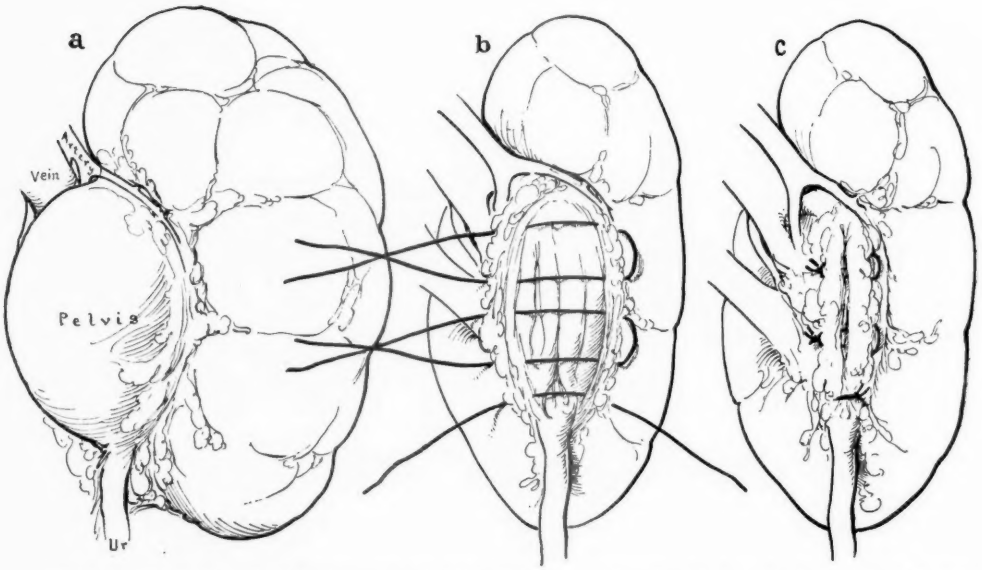


Fig. 2. *a*, The large pelvis of a hydronephrotic kidney where the obstruction has been due to downward displacement. This pelvis is not large enough to call for the plication in a V spoken of in the text, but will be sufficiently restrained by corseting in its own fascial layer in the manner shown in *b* and *c*. *b*, Method of applying the sutures through the fascial layer so as to tuck in and restrain the pelvis from overdistension after the kidney has been suspended. *c*, Suture tied, showing the dilated renal pelvis completely tucked in. In an aseptic operation I did not hesitate to use silk sutures.

Let me observe that there is also an investiture of the vertex of the bladder with a fascial layer analogous to this, which is also of the utmost importance in securing a firm supporting splinting line over the layer or two layers of sutures with which we close the bladder wall. Here I like to use a fine silk continuous suture.

OPERATION FOR CYSTOCELE

By W. P. GRAVES, M. D., Boston, Massachusetts

THE problem of cystocele which formerly was such a difficult one for surgeons, has in recent years been frequently solved, as is attested by the excellent results published by numerous operators. Undoubtedly the reason for this greater success is due to a more complete realization that the condition of cystocele is only a part of a general pelvic or perineal relaxation of the genital organs, and that the operation of the cystocele itself depends largely for its success on the attending operation or operations for the other conditions which are factors in this general relaxation. It is unquestionably true that any method skillfully applied, by which the anterior wall of the vagina is reduced to its normal contour, will usually effect a permanent cure of the cystocele if the accompanying relaxation of the perineum and descensus of the uterus are properly repaired; and conversely it is true that any method of operation on the cystocele itself, no matter how skilfully performed but without regard for the other factors in the relaxation will be almost universally unsuccessful. The claim for success in the present series of cases is based on an appreciation of this important fact,

rather than on any new principle involved in the operation.

The operation itself, although evolved by the writer after the trial of numerous other methods, is essentially a combination of the longitudinal and transverse operations described by Emmet many years ago. In most cases of cystocele it can be shown that the cystocele may be divided into two parts, one an oval-shaped hernia of the bladder, the long axis of which corresponds to the long axis of the vagina, and secondly, the transverse, more or less irregular protrusion which corresponds to the level of the anterior third of the urethra. This transverse protrusion may be a urethral hernia, but is more commonly an hypertrophied mass of connective tissue in which the urethra is not involved. Either the transverse or longitudinal protrusion may exist singly without the other.

The operation to be described aims to reduce these two component parts of the cystocele in such a manner as to restore the anterior wall to its natural contour and to eliminate all irregularities and protrusions which may impinge on a snugly repaired perineum. The operation as it is now performed by the writer is somewhat less complicated than formerly described (Boston Med. and Surg. Jour., April 26, 1906, and Am. Practice of Surgery, vol. vi, p. 609), but the essential principle is the same.

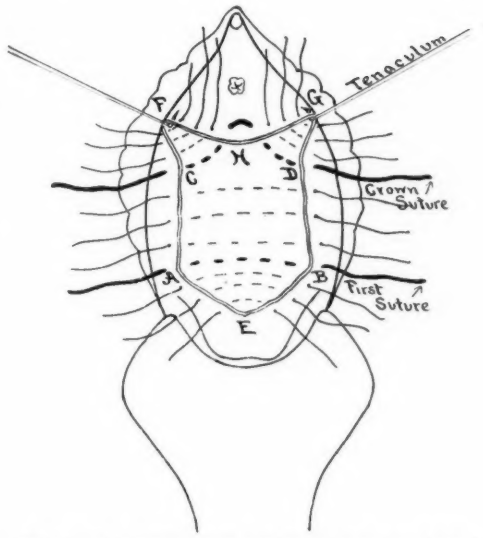


Diagram showing the area of denudation and method of placing the stitches in the operation of the anterior wall of the vagina for cystocele. The stitches marked "Crown Suture" and "First Suture" are drawn more heavily than the others merely for purposes of clearer illustration.

TECHNIQUE OF THE OPERATION

Two points (F and G), are first selected on either side of and just below the urethra; tenaculum hooks are inserted, and drawn sharply outward by an assistant, and held in this position during the entire operation. This exposes the entire cystocele.

Two symmetrical points (A and B), are then chosen anterior to the cervix and well out toward the lateral creases of the vagina. These two points grasped in tooth forceps are drawn together toward the middle line so as to fold the cystocele back. They should be selected so that when they are brought together in the median line the cystocele between the two points will be completely reduced, and the cervix pressed strongly backwards.

These two points in the mucous membrane are then marked so that they can be recognized during the denudation. Two other points (C and D) are then chosen in a similar manner at the lower level of the transverse portion of the cystocele. These points are also marked. Beginning then at point E on the anterior wall of the cervix and its junction with the vagina, the area A, C, D, B, E, which corresponds to the longitudinal portion of the cystocele is first denuded, the denudation being carried out with Emmet's scissors, *not by dissection of a flap*. A suture is then introduced from A to B, the ends being caught in artery forceps and held by an assistant sharply upward, without tying. Sutures are then introduced from A B to E, and tied. The first suture is then drawn downward and sutures introduced above as far as C and D. The point H is then selected below the urethra, which, when drawn downward, will eventually meet the junction of C and D. The denudation of the transverse portion of the cystocele included between C, F, H, G, and D is then carried out. There is usually more bleeding in this area than in the area below. The bleeding points should be tied with fine catgut. The crown suture (see diagram) should then be placed and drawn sharply to one side, while the transverse sutures are placed and tied. The crown suture is tied last.

It is recommended that the steps of the operation be followed out in the order thus described, as the symmetry in the denuded figure may in this way be best preserved, and accurate coaptation of the wound edges accomplished. The wound when completed forms a shallow Y. No. 1 chromic catgut is the best suture material.

The area of denudation should be removed in

strips by means of Emmet's scissors, and not dissected off in a single piece. The operation usually requires from ten to fifteen minutes. When the operation is finished, all irregularities and protrusions of the anterior wall are completely, obliterated, while the contour of the wall is concave toward the bladder. The cervix is pressed firmly back toward the sacrum.

OPERATIONS TO BE COMBINED WITH THAT OF CYSTOCELE

A cystocele operation should never be done singly, as of itself it is inadequate to sustain permanently the pressure of the bladder. The condition of cystocele is invariably accompanied by a relaxed perineum, even in cases where it occurs in nulliparous women. It is frequently accompanied also by a prolapse of the uterus. A neglect either of the relaxed perineum or of the prolapsed uterus will inevitably result in eventual failure of the operation for cystocele. In all cases therefore of cystocele a perineorrhaphy should be performed, the transversus perinei and levator ani muscles being brought together so as to press firmly against the anterior wall of the vagina at the introitus.

When cystocele is accompanied by prolapse of the uterus, the problem becomes more complicated, and an operation for restoration of the prolapse is also required, in addition to the perineorrhaphy.

In order to formulate a simple rule for the proper procedure in treating these conditions, the writer has divided cystocele into two forms, namely, simple cystocele and cystocele with prolapse of the uterus. In cases of simple cystocele the vagina is firmly attached to the rami of the pubes through the medium of the levator ani muscles. When the attachment is intact there is no prolapse and the points of attachment along the sides of the vagina may be used as fixed points of support in reducing the cystocele by an appropriate operation on the anterior wall. Personal experience has shown that simple cystocele combined with a proper perineorrhaphy may be always thus cured permanently by a vaginal operation only.

Cystocele combined with prolapse of the uterus, on the other hand, will invariably recur unless some operation for reducing the prolapse is performed in conjunction with the vaginal operation. The reason for this is that since in prolapse the vaginal support of the pubes is lost, some other fixed point for sustaining the bladder must be sought. Thanks to the fact that the integrity and firmness of the attachment of the uterus to the bladder may always be relied upon, even in the most extreme cases of procidentia, a firm fixation of the uterus to the abdominal wall will also give a permanent suspension to that part of the bladder which is attached to the uterus. It has been shown by experience that if any protrusion remains *below* the uterovesical attachment after abdominal fixation of the uterus it may be permanently cured by a succeeding vaginal operation.

It will thus be seen that the uterovesical attachment which in many operations described is destroyed by stripping the bladder away from the uterus, is made use of by the writer as the keynote to the new support of the bladder in cases of prolapse.

OPERATIONS FOR FIXATION OF THE UTERUS

A detailed description of the various methods of uterine fixation employed by the writer is given in another article (Am. Practice of Surgery, vol. vi, p. 617), but they may be briefly recapitulated thus:

1. Where the prolapse[1] of the uterus is moderate and there is a desire for or likelihood of future childbearing the operation for cystocele is combined with an abdominal shortening of the round ligaments, preferably Kelly's method of drawing the ligaments directly through the recti muscles and suturing them together above the muscles and below the fascia.

2. Where there is prolapse without likelihood of childbearing or where permission is given to tie the tubes for the purpose of causing sterility, the uterus is fixed to the abdominal wall by two silk sutures, one on each side of the fundus, and as far down on the posterior wall as is necessary to reduce the vaginal relaxation.

3. Where there is procidentia[2] without prospect of childbearing the vault of the vagina is attached to the level of the abdominal wall by passing silk sutures through the uterosacral ligaments into the abdominal wall including the muscle and fascia, the two peritoneal surfaces being tied firmly together. If these sutures are properly placed and tied, the permanent fixation of the vault of the vagina is accomplished and with perfect safety and comfort to the patient.

Sixty-nine cases of procidentia have been successfully treated by the writer by this method without recurrence of the prolapse of the uterus.

4. Where there is procidentia in young women who desire more children and the prolapse is too great to be cured by shortening the round ligaments, a complication which fortunately does not frequently occur, the writer is accustomed to employ an operation suggested by Sinclair, by which the uterus is fixed to the abdominal wall by means

[1] The term prolapse s used to denote descensus of the uterus n the axis of the vagina.

[2] The term procidentia is used to denote extreme prolapse where the uterus extrudes partially or wholly from the introitus.

of sutures passed through the anterior wall of the uterus just back of the junction with the bladder.

The evil result described by some operators of fixation of the uterus to the adbominal wall has not been noted by the writer in a single instance in a long series of cases successful in their results both anatomically and symptomatically.

RESULTS OF THE OPERATION FOR CYSTOCELE

The writer has performed the operation described in this article 353 times, including cases of simple cystocele and cystocele combined with prolapse or procidentia. The cases have, with a few exceptions, been followed after operation. There have been three known cases of recurrence. One of these cases followed operation for procidentia, though there was no recurrence of the uterine prolapse. It was among the first few cases done and the recurrence was due to lack of skill in the cystocele operation, as the secondary operation was permanently successful. The other cases were partial recurrences. There has been no case of sepsis of the cystocele wound, and no case of postoperative hæmorrhage. In no case was injury done to the bladder and cystitis occurred in only one instance.

In two cases the anterior transverse part of the wound was drawn too tightly by the crown suture, causing eversion of the urethral mucous membrane. In one case the everted mucous membrane sloughed and healed spontaneously; in the other the everted mucous membrane required resection.

CONCLUSIONS

The successful treatment of cystocele depends more on the judicious treatment of accompanying conditions than on the particular method of treating the anterior vaginal wall itself. The methods described in this article are recommended as being simple, easily performed, without danger of complications, and as securing results, which as skill is acquired are almost invariably successful.

RECTAL ANÆSTHESIA[1]

By JAMES F. CHURCHILL, M. D., Chicago, Illinois

IN presenting the subject of rectal anæsthesia, I make no claim whatever to any original work on the subject, but in view of the fact that this method has been used so infrequently throughout the middle west it seems that a brief account of my own experience and a résumé of the subject may be of interest. As the first account of the use of ether as a general anæsthetic was published in 1846, it appears that the advantages of the rectal method were recognized almost immediately by medical men of that time. The earlier attempts were attended by such disastrous results, however, that the method fell into disuse for many years, so that its practical application is of comparatively recent date.

Roux carried out some experimental work on animals in 1847, and even attempted to induce anæsthesia in clinical patients. His results in his animal work were unsatisfactory, and several of the patients on whom the method was tried developed very serious sequelæ. He noted bleeding from the bowel, severe proctitis followed by sloughing, and, in one or two cases, collapse and death. The method for these reasons was very soon abandoned as unsafe and was not heard of again until 1884. It must be said, in connection with the work done by Roux, that it was based on a principle entirely different from the one now in use, and should hardly be taken into consideration in discussing the subject. I have not seen Roux's original article, but he is said to have injected pure ether and mixtures of ether and water into the bowel. If this be true, it is not surprising that results were obtained as reported.

In 1884 the subject of rectal anæsthesia was revived and a number of successful anæsthesias reported by several operators. Molliere used it successfully at l'Hotel Dieu de Lyon, inducing anæsthesia in from ten to twenty minutes. Hunter, in 1884, reported six cases. Wier, in the same year, reported seven cases, in the service of Dr. W. T. Bull, and two cases of his own. He noted bloody stools and diarrhœa in a number of cases, and collapse in one, following the anæsthetic. Wauscher, in the same year, published an account of twenty-two cases, all of them successful. Post, in 1884, anæsthetized three cases successfully at the Boston City Hospital.

Each of these men made use of the same technique. A bottle containing ether was connected

[1] Read before the Chicago Medical Society, February 16, 1910.

with a rectal tube and then placed in a vessel of hot water. The expansion of the boiling ether forced the concentrated vapor into the bowel. It is not surprising that proctitis, overdistension of the bowel, and even death followed the use of this technique, since liquid ether is very liable to be carried into the bowel, on account of condensation of the concentrated vapor in the rectal tube. And, further, there is no means of judging the amount of ether vapor passing into the intestine, when the ether is boiled.

In spite of the fairly good results reported at this timeand the advantages of the method pointed out by its users, this form of anæsthesia seems to have been abandoned within a short time. At least, no further reports of its use were published until 1905, when Cunningham, of Boston, described a new principle of administration and reported forty-one cases. (An article entitled "Anæsthesia per Rectum" was published by Kruzhilin, of St. Petersburg, in 1904. This article was not accessible.) The modification used by Cunningham was that ether vapor should be carried into the bowel by means of air passed through the ether. By this means the ether vapor is very much diluted, is not liable to condense in the tubing leading to the rectum, and the anæsthetist is able to judge quite accurately the amount of ether the patient is receiving. He also provided for the escape of the air and unabsorbed ether from the bowel, from time to time, by introducing the finger alongside the rectal tube.

Since the publication of Cunningham's article, rectal anæsthesia has been used successfully by many operators in this country and in Europe. Several minor improvements have been made in the apparatus, but the same principle has been used as the basis for all. There is one exception to this statement. Vidal, instead of providing for the escape of the air at intervals, has devised an attachment for the rectal tube which allows a continuous return flow. He has found it very satisfactory. Recently Dumont has published accounts of the use of the older technique, with an attachment for catching the ether which condenses. He evidently is not familiar with the advantages of the Cunningham apparatus.

My own work on this subject consists of a number of trial anæsthesias on dogs, and later the use of the method on forty-seven patients. The patients have been in the services of Drs. Besley, Richter, Kanavel, and Cubbins, at the Post-Graduate, Wesley, and Cook County Hospitals, and I am indebted to them for the use of the material.

All those who have had experience with rectal anæsthesia speak of the great difficulty found in anæsthetizing dogs, on account of the relatively small colon, and a number of writers state that they have been unable to produce profound anæsthesia of these animals. I met with similar difficulties, but was able in two instances to maintain a degree of anæsthesia sufficient for operations on the neck and extremities. These dogs, however, had been morphinized. On account of this difficulty, I find that dogs do not lend themselves to experimental work along this line, nor for demonstrative purposes.

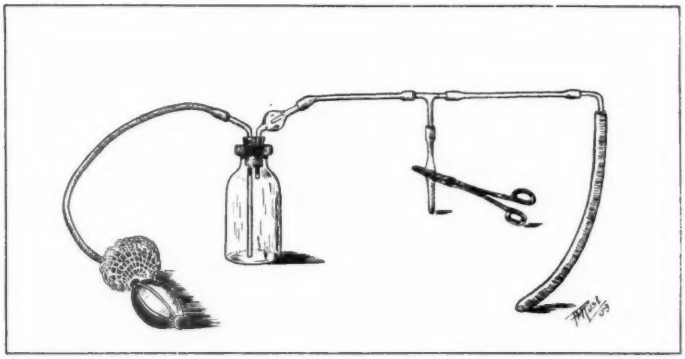
INDICATIONS

The cases in which rectal anæsthesia is of advantage are of two classes. First, operations about the head and neck, in which the anæsthetist and the mask, or other apparatus, interfere with the work of the operator and are a source of danger of infection in the field of operation. The greater ease and rapidity with which the operator can work is of great value, and must be seen to be fully appreciated. This is especially true in operations in and about the mouth.

Resection of the tongue, resection of the superior maxilla, and harelip are examples of the cases in which I have used it to the great satisfaction of the operator.

The second class consists of those cases in which it is desirable to avoid the pulmonary and bronchial irritation caused by the inhalation of ether. In very young children, old persons, and patients who have an existing pulmonary lesion, the danger from inhalation anæsthesia is often very great, so great in many cases as to be a contraindication to a surgical procedure. It is true that ether, however given, is excreted in large part by the lungs, but in the course of rectal anæsthesia the excreted ether is much less concentrated than that taken into the lungs during inhalation anæsthesia, and, in consequence, less irritating. To be sure, the causal relation existing between inhalation anæsthesia and post-operative pneumonia is not well understood; however, it seems reasonable to assume that the attendant cooling and irritation produce in some cases a focus of lowered resistance. I have anæsthetized two patients by the rectal method who had well-marked pulmonary tuberculosis. An amputation was done in each case, because of a tuberculous joint. No aggravation of the pulmonary condition resulted, in either case.

The apparatus I have used is modeled after the one described by Leggett. It is very simple, is easily made, and I have found it entirely satisfactory. An eight ounce bottle is fitted with a two hole stopper. Into one hole is passed a bent glass or metal tube (I have recently used metal, on



account of the danger of breaking of the glass), the inner end of which reaches to within a short distance of the bottom of the bottle. Into the other opening is passed a similar tube, reaching only through the stopper. The longer tube is the afferent, the shorter the efferent. To the afferent tube I attach a hand cautery bulb. To the efferent, a piece of rubber tubing about eight inches long, which, in turn, is attached to one arm of a T or Y tube. This rubber tube may be in two pieces, joined by a short glass tube, so that the anæsthetist may be sure that no condensation is occurring.

The second arm of the T tube is attached to the rectal tube. The third arm is fitted with a short rubber tube, which is closed by an artery clamp. The ether bottle is placed in a jar or basin containing water of a temperature slightly under 37° C. I keep a bath thermometer in the water and find little difficulty in maintaining a temperature varying not more than one or two degrees. Ether boils at body temperature, so that care should be taken not to raise it above that point. The object of the T tube is to provide an outlet for the air and unabsorbed ether from the bowel.

I find the hand bulb to be the best means of supplying air. The foot pump has been used, but is cumbersome, and the anæsthetist is not able to judge so accurately the amount of air forced into the bowel as when the bulb is used. I have used a number of devices, such as small U tubes, lightly packed with cotton, in order to prevent the passage into the rectal tube of any particles of condensed ether or ether carried over, but have discarded them as unnecessary. I find that there is little danger of condensation, if the anæsthetic is given in a warm room. Should condensation occur, I immerse a portion of the efferent tubing in hot water, or wrap a hot towel about the rectal tube. Vidal has described an attachment to prevent this. He connects the efferent tube of the ether bottle with a second bottle, which is placed in a vessel containing water of a temperature of 39° C. This serves as a warming chamber for the vapor. Vidal does not warm the ether itself. The device is a good one, but makes the apparatus more complicated and is, it seems to me, unnecessary.

For adults I use a large rectal tube, and for children a medium-sized urethral catheter. I introduce the tube only three or four inches, just far enough for it to be firmly grasped by the sphincters. Cunningham states that he inserts it ten to fourteen inches. This is unnecessary, and is, I think, a mistake, as the tube is almost certain to be bent upon itself. It is desirable to use a large, stiff tube, having several fenestra. On one or two occasions I have had considerable difficulty, due to using a small or soft tube, which was obviated by changing tubes.

TECHNIQUE OF ADMINISTRATION

In about one-half of my cases I have used the rectal method, throughout the anæsthesia. In the other half the anæsthetic was started by the usual gas-ether inhalation method, the change to the rectal being made after the patient was fully asleep. I shall describe the technique used when started per rectum.

The ether bottle is about two-thirds filled and placed in the vessel of warm water. With the patient in the usual position for anæsthesia, the rectal tube is inserted. The clamp is then taken off the T tube and any gas which may be in the lower bowel is allowed to escape. Having replaced the clamp, the bulb is compressed gently three or four times. The pumping is then stopped and the amount of distension noted by a hand on the abdomen. In thin patients the sigmoid and descending colon become easily palpable. The patient is reassured and asked to state when he feels any distress. After a period of about three

minutes the air and gas is allowed to escape from the bowel, and the procedure repeated. When not using the bulb I put a clamp on the afferent tube, close to the bottle, to prevent ether being forced back into the bulb should the patient cough.

Ether can be detected on the patient's breath in about eight to ten minutes, and he begins to feel drowsy about the same time. In its report in 1908, the Anæsthesia Commission of the American Medical Association states that "the odor of ether appears in three to five minutes and the patient is asleep in six to fifteen minutes." I have never been able to produce anæsthesia so quickly; the time required has ranged from twenty to thirty-five minutes. The patients complain of a sense of fullness, but no distress during this time, and have little or no excitement period. In one case I had some difficulty in convincing the operator that the patient had reached the stage of surgical anæsthesia. One patient who had previously had an inhalation anæsthesia assured me that the rectal was the less disagreeable of the two.

I find that filling the bowel moderately every three or four minutes is usually sufficient to maintain relaxation. I judge the degree of distension by means of a hand on the abdomen and by the number of compressions of the bulb. The important point is to secure the free return of the air from the bowel. In order to be certain of this, I immerse the end of the outlet tube in water and, in this way, can note accurately the amount expelled. If the gas fails to return, it means that the rectal tube is either kinked or plugged. In such an occurrence the tube should be moved in and out or, this failing, it must be removed and cleaned. Under no circumstances is any more air pumped into the bowel until the contained air is expelled.

I make a practice of having an assistant at the patient's head. He observes the same signs as to the degree of the anæsthesia, condition of the patient, etc., as in inhalation anæsthesia, and reports to the rectal anæsthetist. In case of the occurrence of any of the accidents of anæsthesia, the outlet tube is at once opened and the patient treated as in the course of inhalation anæsthesia.

As to post-operative treatment: I leave the rectal tube in place for about an hour after the anæsthetic is stopped. Before it is removed the patient is given from four to six ounces of olive oil through the tube. Cathartic enæmas are given, if the patient has any gas pains later.

I have found the preparation of the patient to be the most important point in the use of this anæsthesia. The patient should have only very light diet for the thirty-six hours preceding the operation. The bowels are moved freely the day before the operation by means of calomel and salines. Six hours before the operation the patient should receive a normal salt or cathartic enæma, to be repeated until the rectum is clear. When this program is carried out, one rarely has any trouble on account of the bowel contents.

SUMMARY OF CASES

While, as I have stated, my experience has been limited to forty-seven cases to date, they have covered such a wide range of conditions and indications that a brief study may be of interest.

Among the operations done under this anæsthesia are resection of the superior maxilla, resection of the tongue, resection of the mandible, harelip, cleft palate, tonsillectomy, craniotomy, removal of tumor of hypophysis, thyroidectomy (simple and exophthalmic), amputations (thigh and leg, in cases of pulmonary tuberculosis), dissection for needle in the hand, dissection of cervical tuberculous glands, inguinal herniotomy, and cholecystotomy. The anæsthesia was satisfactory, from the operator's standpoint, in all cases except the herniotomies. It was tried in two cases, and in each the distension interfered with the operative work. In gall-bladder work there is almost no interference and it can be used, if there is any pulmonary indication. In five of my cases I was unable to maintain anæsthesia and the rectal method had to be abandoned. Four of these failures were due to insufficient preparation of the patient, and the fifth to leaky apparatus. All the other attempts have been successful.

The time of administration has varied from ten minutes to two hours. The time of operating has ranged from a few minutes to two and a quarter hours.

The ages of the patients have ranged from six months to seventy-three years. Several children have been anæsthetized — all with great ease. One patient was anæsthetized three different times without any bad results.

It is worthy of mention that alcoholic patients seem to be held better by the rectal than by the inhalation method. I saw two marked instances of this in my series. The change was made from rectal to inhalation and then back to rectal in one case, to see what the effect would be. The difference was very marked and in favor of the rectal.

The amount of ether used was noted in each case, and was much less than that used in inhalation for an operation of equal length.

POST-ANÆSTHETIC EFFECTS

In my own cases I have seen rectal disturbance but once. This patient had some rectal distress

and a show of blood in the stool, eighteen hours after operation. An oil enæma relieved the distress and there were no further symptoms. He stated that he had had some small hæmorrhoids for some time, and that there had been slight bleeding on several occasions. I am inclined to believe that the irritation and bleeding at this time were due to trauma to the hæmorrhoids.

Post-anæsthetic nausea and vomiting have certainly been much less frequent than after inhalation anæsthesia.

ACCIDENTS AND MORTALITY

I have been unable to discover a death directly attributable to the anæsthetic, as it is now given. One of my cases, an old man on whom a resection of the tongue was done, died suddenly twenty-four hours after the operation. He had had no intestinal symptoms and the bowels had moved freely. There was no blood in the stools. I think this death was not due in any way to the method of anæsthesia used.

One patient, a young woman in good health, was overanæsthetized. The anæsthetic was started by gas-ether inhalation and the respiratory failure occurred within a few minutes after changing to the rectal. Artificial respiration was carried out at once, the patient revived promptly and the anæsthetic was continued without accident.

Cunningham (1907) reports two deaths occurring after rectal anæsthesia, but thinks that neither was due to the anæsthetic. One, a boy of six, died at the end of a long operation for tuberculous glands of the neck, apparently from surgical shock. The second, a woman sixty-three years old, operated for carcinoma of the neck, died thirty-six hours after operation. Not an anæsthetic death.

Eggleson, of Seattle, Washington, reports the death of a two-year-old child, forty-eight hours after operation. He believed it to be due to acetonuria. Allen, of the Massachusetts General Hospital, reports two deaths. A sixty-five-year-old man, operated for carcinoma of the superior maxilla, died thirty-six hours later of shock. The second case was an old man, weighing two hundred and thirty pounds, on whom a neck dissection was done for carcinoma of the lip. His condition was bad throughout. Seven ounces of ether were used, per rectum, in forty minutes. He had six or eight blood-tinged stools, following the anæsthetic. Death at the end of twenty-four hours. The operator did not blame the anæsthetic.

It will be seen that these cases, with the possible exception of the last, cannot be considered anæsthetic deaths. They were all bad surgical risks.

Dr. W. S. Sutton, of Kansas City, formerly a member of the house staff at Roosevelt Hospital, states in a personal communication, that there was no anæsthetic mortality in the series of 140 cases at Roosevelt, though one case died two hours after the operation, after having regained consciousness. Bloody stools occurred but once in the last 115 cases.

Cunningham (O. J.), in a report prepared for the anæsthetic commission of the American Medical Association, makes the statement that rectal anæsthesia has been used in fifteen thousand cases without a fatality. I have not been able to collect any such number of cases.

CONCLUSIONS

1. Rectal anæsthesia may be used with advantage to the operator and greater safety to the patient in operations about the head and neck and on patients who have some pulmonary lesion.
2. It cannot be used in abdominal work on account of the intestinal distension.
3. No difficulty is encountered in its administration if the patient is properly prepared and the apparatus properly constructed.
4. Post-anæsthetic nausea and vomiting are less marked than after inhalation anæsthesia.
5. The various complicated devices in use are unnecessary and undesirable, since the simple apparatus is entirely satisfactory.
6. In the hands of experienced anæsthetists the method is as free from danger as inhalation anæsthesia.

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THE TREATMENT OF ECLAMPSIA BY DILATATION OR INCISION OF THE CERVIX[1]

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IN 1890, a stranger in a strange town, recently elected to membership in the Grand Rapids Academy of Medicine, I was asked to read a paper before this society. The subject selected for this paper, my maiden effort in medical writing, was eclampsia. It seemed fitting, in response to the kind invitation of your secretary, that I should prepare a paper for your consideration upon the same subject, for eclampsia is just as interesting, if not more so, to-day than was the case twenty years ago. These twenty years have not been without great effort and labor on the part of hundreds of workers to discover the cause of this dread disease with its high mortality, which every year complicates the pregnancies and labors, according to Fry, of over 6,480 women in this country alone. How much has been accomplished by all this work? So far as our knowledge of the etiology of eclampsia is concerned are we any better off to-day than we were twenty years ago? I feel that I should be guilty of disrespect to my first born, did I not here seize the opportunity of quoting from this paper of twenty years ago. After speaking of the more or less exactness of operative obstetrics, the question of eclampsia is considered as follows. "But how different is it when he (the physician) is brought face to face with puerperal eclampsia. The nature of the case before him demands immediate action, yet with what a different feeling does he begin his task. His diagnosis is usually clear, the same skill and courage exist, but one essential feature is lacking, he is not sure of his pathology. He has a feeling that although some pathological points are settled, still there remains something yet undiscovered, which when ascertained, may change in a great measure his treatment. It is only by the accumulation of facts, brought to light by patient clinical and pathological research, that we can hope ever to solve the problem."

These statements are just as true now as they were twenty years ago. We are still ignorant of the true cause of eclampsia. We still feel that discoveries yet to be made will lead us to change our treatment. But while the goal has not yet been reached, so far as the primary cause of the disease is concerned, we are much nearer the solution of the problem than was the case twenty years ago. Then our whole attention was focused upon the kidney changes. To-day we know that while such changes are most constant in eclampsia, degeneration of the convoluted tubules occurring in over 95 per cent of the cases, such degenerations are not confined to the kidneys but are found in varying degree in the liver, brain, heart, and other organs. These pathological changes are more or less constant in eclampsia and permit it to be distinguished on the post-mortem table from other toxæmias. Holland in the three last numbers of the Journal of Obstetrics and Gynecology has published a most admirable critical review of the recent work on the etiology of eclampsia. He says that "the past six years has been a particularly fertile period, and the year 1908 alone saw considerably over one hundred scientific papers on the eclampsia problem. The real difficulty is to distinguish good work from bad and to maintain a due sense of proportion. The reason of this concentrated output of work is not far to seek. A problem like eclampsia is attacked at every side and by every method; advances in general pathology, in biological chemistry, and in other branches of science, afford new means of attack. This desperate onslaught of the etiology of eclampsia may be directly traced to the great strides that have been made in our knowledge of (1) the general metabolism of the body; (2) the theories of immunity; and (3) the action of intracellular ferments and the conception of autolysis." In part his conclusions as regards the etiology of eclampsia are that:

1. There is no special eclamptic toxin.

2. Eclampsia is an auto-intoxication due to a profound disturbance of protein metabolism.

3. In eclampsia, intracellular ferments are raised in activity, cause autolysis of cells and produce toxic substances.

4. In the light of present knowledge the most probable theory of the cause of eclampsia is an intoxication of the body by the passage of ferments and autolytic products from the placenta into the circulation, the principal effect of which is increased coagulability of the blood and the activation of autolytic ferments in other parts of the body.

For obvious reasons with such a broad subject as eclampsia, it becomes necessary for an essayist to limit himself to a single phase of the subject.

[1] Read by invitation before the Grand Rapids Academy of Medicine, January 19, 1910.

Consequently, I have chosen for your consideration this evening one of the practical problems in the treatment of the eclamptic patient. For after all is said the problem before the great majority of those who have to deal with eclampsia at the bedside, is how to save the patient's life and how to prevent the disease developing in future cases. To most of us the immense amount of work being done on the etiology of eclampsia is interesting only as it aids us in the intelligent treatment of the eclamptic. So we read and absorb according to our capacities all that the research workers tell us about protein metabolism, intracellular ferments, and autolysis. Then comes the weighing of evidence, the cautious trial of conclusions that seem reasonable to the doctor who is not treating an animal in a laboratory but has a human life dependent upon his skilful and common sense treatment.

I have selected for discussion the question of whether in antepartum eclampsia the cervix should be dilated or incised, and propose to discuss it under the following headings:

1. Should the uterus be emptied in antepartum or intrapartum eclampsia?

2. In case it be determined to empty the uterus in eclampsia, should the cervix be dilated or incised?

SHOULD THE UTERUS BE EMPTIED IN ANTEPARTUM OR INTRAPARTUM ECLAMPSIA?

It is obvious that if we accept the conclusion that eclampsia is due to a profound toxæmia, no matter what may be the primary cause of the eclampsia or where situated, we have to do with a patient who is not in the best condition for operation. Unless, then, our own experience or the experience of others convinces us that the patient will be the gainer by emptying the uterus whatever means be employed, it will be far better to depend upon medical treatment to combat the eclamptic seizures. It has always seemed to me a reasonable proposition, since the eclamptic condition is undoubtedly due to the fact that the patient is pregnant, that the sooner gestation is ended the better it would be for the patient. The answer to this argument so often made by those who advocate expectant treatment and advise against all forms of operative interference, that eclampsia often occurs postpartum where it can not be due to the presence of the child, has little weight when carefully considered in the light of what is known to-day of the pathology of the disease. The postpartum eclamptic attack develops because while the child was within the uterus, the toxæmia became so marked that evacuation of the uterus proved of little avail. We are in no position to judge clinically how much damage has been sustained by the liver, kidneys, brain and other organs through the action of the poisons manufactured in the pregnant woman's economy. One patient may exhibit all the classical symptoms of profound intoxication, headache, visual disturbances, epigastric pain, œdema and renal signs, yet all will disappear after labor. In another patient many of these signs may be absent or not marked, yet postpartum eclampsia will develop and the most advanced degenerative changes in the liver, kidneys, heart, and brain will be found at the post-mortem. Fortunately, in the majority of cases the intoxication is favorably affected by the delivery, as shown by the small number of cases of postpartum eclampsia and their favorable outcome. Williams has observed the postpartum variety in comparatively few instances. Olshausen, Knapp, Goldberg, Partridge, and Reinburg have met with it respectively in 14, 14.6, 17, 21.6, and 20 per cent of their cases. In Green's series, however, 42 per cent were of the postpartum variety. His mortality was high, since 6.6 per cent of his cases were lost. Zweifel lost 9.5 per cent, Olshausen 25 per cent, and Partridge 33.3 per cent of their cases, although the latter had too few cases to serve as a criterion.

So far as statistics are concerned the advocates of immediate operation are able to show infinitely better results than those who depend upon expectant treatment. Liepman from the statistics of Würzburg, Basel, Halle, and Berlin, found a mortality of 25 to 30 per cent in 79 cases of eclampsia treated expectantly. This mortality was reduced by immediate delivery to about 2 per cent. Bumm's statistics from the clinics at Halle and Berlin Charité show that the mortality of 25 or 30 per cent under the expectant plan of treatment was reduced to between 2 and 3 per cent under treatment by immediate delivery. Zweifel reports a mortality of 28.5 per cent under expectant and 11.25 per cent under active treatment. Under the expectant plan of treatment the mortality of eclampsia is usually placed as high as 25 to 30 per cent. In Orten, where there were no physicians and presumably no operative treatment, it reached 34 per cent. On the other hand Glockner, in 143 cases places the maternal mortality with operative interference at 15.49 per cent. Ferri of Milan in 82 cases of eclampsia treated by artificial dilatation of the cervix reported a mortality of only 7 per cent. Fry reported recently 15 cases of prompt evacuation of the uterus for eclampsia with only one maternal death.

These figures are convincing enough for any one and show the immense superiority of active inter-

ference in eclampsia over the expectant medicinal treatment.

WHEN SHOULD THE UTERUS BE EMPTIED?

If the above is correct and the patient stands a better chance for recovery in antepartum eclampsia when the uterus is evacuated, it would also seem to be the sensible thing to resort to such interference as soon as possible after the first eclamptic seizure. Personally, I believe the indication for operative interference should be extended to those pre-eclamptic cases where in spite of the most thorough eliminative treatment, the patient is seen to be growing progressively worse. By neglecting evacuation of the uterus in these cases, I believe we are subjecting the patient to unnecessary risk, for cases have been reported where the first convulsion resulted in death. Are we not as remiss in refraining from operations in these cases as we are when we hesitate until too late in cases of hyperemesis gravidarum?

I am in hearty accord with Fry when he condemns the practice of wasting valuable time in eliminative treatment in antepartum eclampsia, when the proper plan should be to stop fœtal metabolism and maternal intoxication by prompt evacuation of the uterus. If the woman be in labor and the pains strong it is questionable whether means should be employed to dilate the os if the convulsions can be controlled. But where labor has not begun or in cases of intrapartum eclampsia where the pains are slight and delivery delayed, the indication is to evacuate the uterus as quickly and with as little shock to the mother as possible.

WHAT ABOUT THE CHILD?

The trend of modern obstetrics is to place more and more va'ue upon the life and safety of the child. Craniotomy on the living child is only permissible under the rarest circumstances. Hence in any treatment of the complications of pregnancy, it is necessary to give due consideration to the interests of the child. Other things being equal, in case it becomes necessary to interrupt pregnancy, it is obligatory upon the obstetrician to choose that operation which will give the child the best chance for life. This is true, provided the maternal chances are not too greatly diminished by the operation decided upon.

The fœtal mortality is notably high in eclampsia. According to Wyder the fœtal mortality is 36 per cent, 42 per cent according to Büttner, 45 per cent in Goedecke's series and even 75.4 per cent in Friedemann's statistics of 1,601 cases of antepartum eclampsia. However, it must be noted that in the latter series there were many premature children. It is evident that statistics regarding fœtal mortality in eclampsia, both with and without operative interference, will depend upon the period of gestation in which the eclampsia appears. The earlier the patient has an eclamptic attack, the less the chance for the child, whether the uterus be immediately emptied or the expectant plan of treatment be adopted. Not only are there marked degenerative changes in the placenta due to the eclamptic poison, thus interfering with the nourishment of the fœtus, but characteristic lesions of eclampsia are found in the organs of the fœtus. Whether these are sufficient to establish the fœtal origin of eclampsia is still a mooted question. That their presence shows the danger to which the fœtus is subjected in this disease is beyond dispute.

It has been pretty conclusively shown by a number of observers that the greater the number of eclamptic seizures before the birth of the child, the less chance the latter has of living. Hence it follows that the sooner the child is born after the fi st eclamptic convulsion the better it is for the child. This is an additional argument for early interference in eclampsia. The kind of operation most favorable to the child will be considered under the next heading.

IN CASE IT BE DETERMINED TO EMPTY THE UTERUS IN ECLAMPSIA SHOULD THE UTERUS BE DILATED OR INCISED?

It must be understood that in this paper we are dealing with only a small portion of a very large subject. From lack of time it becomes impossible to discuss the various kinds of medicinal and eliminative treatment which necessarily are most essential in every case of eclampsia. Every form of operative treatment is far from ideal and is only resorted to because of the exigencies of the case and because we are forced to the conclusion that the eclamptic woman is better off with an empty uterus. What we are seeking is the kind of operation under varying conditions by which the uterus can to be emptied quickly with a minimum amount of injury and shock to the patient, at the same time with a due regard for the interests of the child.

In threatened eclampsia it may be considered advisable to adopt the slower methods of dilating the parturient os, or rather the starting up of labor pains so that later on the os may be dilated, through the use of the bougie, the cervical gauze pack, or the bag. But such methods are entirely out of place in the presence of eclamptic convulsions for they are too slow to meet the principal indication, the rapid emptying of the uterus. There remain

for consideration, then, five rapid methods of quickly terminating the pregnancy.

1. Manual dilatation of the cervix.
2. Instrumental dilatation of the cervix.
3. Cervical incisions.
4. Vaginal Cæsarean section (vaginal hysterotomy.)
5. Abdominal Cæsarean section.

1. MANUAL DILATATION OF THE CERVIX

This is the most popular method of dilating the parturient cervix, and deservedly so. When the cervix is soft and yielding and admits one finger, if Harris' thumb and finger method be employed, dilatation sufficient for the application of forceps or version can usually be secured within one or two hours. It works very well with multiparæ and badly in old primiparæ with rigid cervices. The great difficulty is that the practitioner is not, as a rule, familiar with the Harris method, where the dilatation is secured by a snapping motion after passing the finger and thumb through the cervix. The usual method employed is to force the fingers upward, thus reversing the natural process, where the internal os is dilated first. Furthermore, it is almost impossible where the fingers in the shape of a cone are pushed upward, to estimate the amount of force employed. In the hands of one who thoroughly understands the method, who has muscular fingers, and employed in suitable cases where the tissues are sufficiently yielding, the cervix can be dilated by the Harris' method in a little over half an hour. In the hands of the practitioner it often fails because these conditions are not present. Not only is the operation prolonged, but the constant changing of hands, as the fingers become numb from the pressure, is apt to result in infection from the carrying of fœcal matter upward from the anus. Too much force is apt to be employed leading to the bruising of tissues and cervical tears. The method is entirely unsuited to rigid cervices, where it should give place to a cutting operation.

I have had no experience with Edgar's bimanual method. It has given good results in the hands of its originator and in some of the foreign clinics, notably Treub's in Amsterdam where Meurer and Meulemann report favorably upon its use. It would seem as difficult, if not more so, to guard against sepsis by this method as by the Harris method.

2. INSTRUMENTAL DILATATION OF THE CERVIX

This is accomplished by powerful dilating, steel instruments of which the Bossi pattern serves as a type. I have tried this instrument twice, cervical tears resulting in each instance in spite of extreme care in its use. It should never be used until the cervix has been taken up, else tears even into the broad ligaments or peritoneal cavity may result. Bardeleben and others have shown by the examination of women delivered by this method that severe lacerations result in quite a proportion of cases. Gauss at the last international congress of medicine reported 75 cases treated by the Bossi method. His conclusions are that this method should not be employed early in pregnancy when the soft parts are not relaxed. In other words it is indicated where manual dilatation is the better operation. At the same congress Winter called attention to the fact that one could not avoid lacerations by Bossi's method unless the cervical canal was completely taken up and the os externum at least as big as a shilling.

To my mind in spite of the good results reported by Bossi in 395 cases and the support it has received at other hands, it will always be a dangerous method and for that reason will never come into very general use.

3. CERVICAL INCISIONS

These incisions, as popularized by Dührssen in 1890, are limited to those cases where labor has obliterated the cervical canal but the external os does not dilate. Wyder and Holmes contend that in addition to cervical effacement, the presenting part must have engaged in order for cervical incisions to be indicated. The incisions, four in number, may be made with the scissors under the guidance of the fingers down to the vaginal junction. According to Holmes if these cuts be made obliquely, better healing will result. Such incisions have not been popular in this country on account of the danger of their extending as the child is extracted, thus giving rise to profuse hæmorrhage. Personally, I have had no experience with such incisions and judge that they will be replaced by the more accurate incisions of the vaginal Cæsarean section, although the indications for the latter are hard, undilated cervices rather than the conditions set forth above.

4. VAGINAL CÆSAREAN SECTION (VAGINAL HYSTEROTOMY)

This operation, first described by Dührssen in 1896, is the ideal operation for rapidly emptying the uterus in eclampsia. It will never entirely supersede manual dilatation, since it is evident that the latter operation will always be employed in certain cases where the cervix is easily dilatable, either in primiparæ or more especially in multiparæ. It is unnecessary to describe the technique of

vaginal Cæsarean section, which is sufficiently familiar to you all. It is not a particularly difficult operation, provided the uterus can be pulled downwards sufficiently to expose the cervix. Unlike the non-puerperal cervix the vaginal mucosa and bladder are easily pushed upward by two or three strokes of the sponge after the initial incision. A sponge or retractor will protect the bladder from injury as the anterior cervical wall is split upward by the scissors in the median line. There is practically no bleeding, if care be exercised not to let this incision deviate from its median position. After the eighth month it is best to split the posterior as well as the anterior wall. No difficulty will be experienced in ending the operation by version or high forceps, preferably the former if the amniotic fluid has not drained away. The operation is quickly performed, the child being easily extracted in from five to ten minutes after the initial incision. I have never had to use the lateral vaginal incisions recommended by Dührssen, introduction of the hand into the vagina always proving sufficient. No sepsis has resulted from the operations, the wounds apparently healing by primary union.

Dührssen has collected 112 cases of vaginal Cæsarean section for eclampsia with a maternal mortality of 15 per cent. Veit had a series of 33 cases of eclampsia where vaginal Cæsarean was employed with only one death, and that from pneumonia from which the patient suffered prior to the operation. From the large number of these operations reported in this country and abroad the procedure is apparently growing in popularity. I firmly believe, as we become more and more familiar with its technique and its limitations, that the indications for the operation will be extended in eclampsia and with its clean incision it will more and more encroach upon manual dilatation until only the very easily dilatable cervices are reserved for that operation.

5. ABDOMINAL CÆSAREAN SECTION

This operation for antepartum eclampsia is only mentioned for the sake of completeness. It should be reserved for cases of contracted pelvis complicated by eclampsia or in the presence of other conditions precluding delivery of the child through the natural passages. The mortality of the operation in eclampsia has always been high since it was first performed for this indication by Halbertsma in 1878. Hammerschlag in 1904 collected 34 cases of abdominal Cæsarean section for eclampsia with a mortality of 55 per cent. Four of these patients or 12 per cent, died of sepsis. It is possible that if from these could be eliminated the cases where previous attempts at dilatation or extraction from below had been made the statistics would be better. Certainly Cæsarean section, unless of the extraperitoneal form, is contraindicated in eclampsia except as a last resort when the patient has been infected from below.

RESULT OF OPERATIONS AS REGARDS FŒTAL MORTALITY

Naturally the most favorable operation from the child's standpoint is the classical Cæsarean section. Friedemann reports 36.5 per cent mortality after this operation as compared with 56.4 mortality after vaginal Cæsarean section. These figures, however, do not mean much unless the cases be carefully analyzed to ascertain at what periods of gestation the operations were performed. As a general proposition we may say the quicker the operation, the sooner it is performed after the first convulsion and the less the force with which delivery is accompanied, the lower will be the fœtal mortality. This is true provided the interruption of gestation has occurred after the period of viability of the child, a period much later in eclampsia than in other complications of pregnancy.

CONCLUSIONS

1. While the cause of eclampsia is yet unknown, the intoxication evidently is intimately associated with a disturbance of protein metabolism.
2. Since the auto-intoxication is caused by the pregnant state, it follows that the desideratum for the eclamptic is the cessation of pregnancy.
3. In a large proportion of cases the eclamptic seizures cease after the uterus has been emptied.
4. Postpartum eclampsia occurs because of the severity of the intoxication prior to the evacuation of the uterus. In other words the intoxication was so profound that its results could not be completely averted by the emptying of the uterus.
5. The mortality of eclampsia is much less under the plan of immediate delivery than under expectant treatment.
6. No time should be wasted in medicinal treatment after the first eclamptic seizure, but the uterus should be emptied at once.
7. Such treatment not only will be best for the mother, but it will give the child the best chance for life.
8. The slow methods of emptying the uterus through the use of the bougie, the cervical pack, or the bag are not applicable to eclampsia.
9. That method should be chosen which will empty the uterus quickly with a minimum amount of injury and shock to the patient.
10. Where the cervix is soft and easily dilatable this can be best accomplished by manual dilatation.

11. Instrumental dilatation is too apt to result in severe cervical lacerations even in skilled hands, to make it a desirable method for the practitioners.

12. Vaginal Cæsarean section is the ideal operation for rapid evacuation of the uterus in eclampsia.

13. Abdominal Cæsarean section for this condition, while giving good results so far as the child is concerned, has such a high maternal mortality, that the operation is contraindicated except in eclampsia with contracted pelvis or where delivery through the natural passages for other reasons is impossible.

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PRELIMINARY REPORT ON THE USE OF OXYGEN IN THE TREATMENT OF ASPHYXIA NEONATORUM[1]

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Although not in itself a purely obstetrical subject, nevertheless all obstetricians are directly concerned with the treatment of asphyxia of the newborn.

The condition is one of oxygen starvation plus carbon dioxide poisoning, produced by numerous causes; and the two types — livid and pallid — are different degrees of the same process.

With the better understanding and application of obstetric indications in recent years, many of the causes of asphyxia and destructive operations on the fœtus are things of the past. Nevertheless, there are instances where sadness instead of happiness is the portion of the prospective parents because the child does not live, and the physician feels robbed of much of his hard-earned reward when he is unable to resuscitate the infant which he has delivered with great difficulty and over whom he has labored long in a vain attempt at resuscitation.

Many methods have been proposed to overcome this condition. That of Schultze is often used, yet it is not without danger as is shown by the recorded instances of fractured clavicle with perforation of the lung, dislocation of the shoulder, ruptured liver, and injuries resulting from allowing the slippery infant to escape from the hands and be thrown to the floor or against the wall.

Direct insufflation is open to criticism since the air injected into the infant's lungs is charged with carbon dioxide and loaded with millions of microbes of many varieties; the practice of placing gauze over the child's mouth cannot be a sufficient safeguard, and there is also the danger that the operator may be infected.

Sylvester's method is rarely effectual in the new born, and it is a waste of valuable time to use it.

Realizing that the predominant causative factor in these cases is a deficiency of oxygen, two years ago (on the service of Dr. John O. Polak, at the Methodist Episcopal Hospital) I began the use of oxygen for the purpose and have found it of decided advantage.

Immediately following the birth, our mode of procedure is as follows:

Holding the child in the inverted position with the left hand, after having wrapped a towel around the feet to prevent slipping, the mucus is then removed from the mouth and nostrils; and if there seems to be an abundance, its removal is facilitated by having an assistant compress the chest, while still in the inverted position, as suggested by Prochownik. The back should then be rubbed or slapped and if the child then fails to breathe or cry, the cord should be cut (and, in the livid type, before clamping about one or two drams of blood should be allowed to escape from the cord). The infant is then tubbed in hot water, 105° Fahr., and the method of Byrd followed, which method consists briefly, in alternately folding and unfolding the child like a book, or, as more minutely described by Dr. Byrd: "Bring the ulnar sides of the hands together with the palmar surfaces looking vertically; then prop them beneath the back of the infant so that the extended thumbs may aid as far as possible in sustaining the vertex and inferior extremities. Then, keeping the ulnar borders of the hands in contact so as to form a fulcrum, the radial borders or sides are simultaneously depressed to as great an extent as practicable, say 45 degrees, below the horizontal line and then gradually elevate or pronate as many degrees above that line, thus facilitating the escape of air drawn into the lungs during the downward movement of the head and chest." This method we carry out while the child is still in the water, with the face held above the surface.

While this treatment is in operation, a funnel, either of glass or rubber, about three or four inches in diameter, attached by rubber tubing to a tank of oxygen, is held as closely as possible over the child's mouth and nose and the oxygen allowed to flow very freely, in fact at full force. The irritation to the respiratory tract produced by the oxygen causes rapid respirations and crying, with full expansions of the chest; the oxygen is continued, and the pallid or livid hue in a few seconds gives way to a most welcome bright, rosy color. Occasionally, in extreme cases, we make use of Laborde's method, the rhythmic traction on the tongue eight or ten times a minute which can best be accomplished with a suture through the tongue, in conjunction with Byrd's method, and with the funnel still at the mouth.

After respiration is well established, the child

[1] Read before the New York Academy of Medicine, Section of Gynecology and Obstetrics, April 20, 1910.

is removed from the tub, dried, the cord dressed, and when well wrapped is laid on the right side with a hot water bag to the back.

It is a good plan to make these children cry once an hour for several hours, and if the color is not of the best to continue the administration of oxygen in small quantities.

In a hospital a tank of oxygen is always at hand, and in private practice one should be procured in those cases where a difficult resuscitation is for any reason anticipated.

To sum up: An insufficiency of oxygen being the cause of asphyxiation in the new-born, our manner of using it seems a reasonable procedure; it is harmless, it greatly lessens the exposure and eliminates the traumatism that results from the use of some methods, it saves valuable time, and it gives living children when other methods fail.

A NEW UTERINE FORCEPS

By ALBERT J. SCHOENBERG, M. D.
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The uterine forceps illustrated in the accompanying cut were devised for the purpose of elevating the uterus for operating on the tubes, ovaries, or round ligaments. They are especially useful for holding up the uterus when retrodisplaced, facilitating any of the various round ligament operations.

The method of catching and holding the uterus with tenaculæ leads to lacerations and hæmorrhage, making this method very unsatisfactory to the operator when the uterus is to be left.

The uterine forceps shown are simple, easy to manipulate, have no serrations or sharp edges. The rubber slips on and may be removed with ease, and when worn can be replaced by a snug-fitting soft, rubber catheter or rubber tubing. The jaws are so shaped that the fit is snug around the uterus when set, thus equalizing pressure. It is secure in its hold and does not traumatize.

ABSTRACTS OF CURRENT LITERATURE

DEPARTMENT OF SURGERY

UNDER THE CHARGE OF

FREDERIC A. BESLEY, M. D.

GEORGE E. BEILBY, M. D. — WM. R. CUBBINS, M. D. — AIMÉ PAUL HEINECK, M. D.

WM. C. DANFORTH, M. D. — FREDERICK G. DYAS, M. D. — G. T. COURTENAY, M. D.

FRED C. ZAPFFE, M. D. — JAMES F. CHURCHILL, M. D. — B. J. O'NEILL, M. D.

ARTHUR B. EUSTACE, M. D. — JOHN A. WOLFER, M. D. — H. A. POTTS, M. D.

HÆMOLYSIS IN SURGERY

A REVIEW OF RECENT LITERATURE

BY FRED C. ZAPFFE, M D.

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The hæmolytic tests are made by mixing the serum of the patient with stated quantities of suspensions of washed human red blood cells from normal individuals. The tubes are kept in the thermostat for a number of hours, and the presence or absence of hæmolysis is determined by the appearance of the supernatant fluid after the red cells have settled. If hæmolysis has taken place, the fluid is colored pink or red by the hæmoglobin which has been set free. By this method, the degree and presence of hæmolysis is determined by the amount of laking of the red cells. The hæmaglobin is therefore the indicator. The test tube reaction gives no evidence of other substances which have been liberated. A small amount of hæmolysin in the serum that is being tested may be insufficient to hæmolyze enough cells to produce a coloration of the supernatant fluid appreciable to the eye.

It occurred to one investigator that it might be possible to gain a better knowledge of the hæmolytic properties of the serum of human beings with malignant disease, if red cells from a normal individual were brought into contact with the serum of patients *in vivo* — that is, if the cells were injected under the skin of the patients.

Theoretically, there might be certain advantages in such a method. If normal red blood cells are injected under the skin of a patient whose serum is hæmolytic, fresh quantities of hæmolysin would be continually brought to the cells by the circulating blood lymph, and therefore — even if the amount of the hæmolysin in the blood of the patient was very small — the injected cells might nevertheless be hæmolyzed. Every organic substance which was liberated by the destruction of the injected red cells would enter the tissues and there have its effect. The hæmoglobin and other substances which had been set free might cause a local change in the tissues at the site of the infection. If blood cells are injected under the skin of a normal individual, they are broken up and carried off by the body cells and fluids; the condition of affairs under the skin of a patient whose blood serum contains free hæmolysins would be an entirely different one because a different process was taking place.

These theoretical considerations led one investigator to suggest that injections of washed human red blood cells from normal individuals should be made under the skin of normal and of diseased individuals, in order to determine whether a local reaction was produced, and if so, if there was anything characteristic

in the appearance of the skin at the site of the injection in patients who suffered from carcinoma. A decided local reaction was observed in a large percentage of the patients with malignant disease, while no reaction was observed in a large percentage of normal individuals or of those with other diseases.

The blood is obtained in the following manner: Into an ordinary aspirating syringe of 10 to 15 cc. capacity a glass bead about the size of a split pea is placed, and the syringe and needle are boiled in normal saline solution. The anterior aspect of the elbow of the individual whose vein is to be aspirated is carefully cleaned with soap and water, alcohol and ether, and a vein made prominent by tying a bandage around the arm. Under proper aseptic precautions the vein is punctured and 5 to 10 cc. of blood is aspirated into the cooled syringe. The needle is then removed from the syringe, the end of the latter covered with a piece of sterile gauze, and the syringe shaken for ten minutes. After the blood has been defibrinated in this manner, about 1 cc. is expressed into each of a number of sterile test tubes that fit into an ordinary centrifuge, and that have been previously half-filled with sterile normal salt solution. The usual bacteriologic technique (passing the ends of the test tubes through the flame, etc.) is employed to keep the contents of the tubes sterile. The tubes are now placed in the centrifuge for ten minutes. The clear supernatant fluid is then carefully poured off from each tube under the proper precautions to prevent infection. Fresh sterile salt solution is added, the tubes are gently shaken to mix the blood with the solution, and the tubes are again centrifuged for ten minutes. The same process is repeated a third time. Then, after the supernatant fluid has been poured off, four times as much salt solution as there are cells by volume is added. Thus, approximately, a 20 per cent suspension of washed red blood cells has been obtained. The tubes are kept in the ice chest for 24 to 48 hours, and are then ready for use. Any tubes in which there is the slightest amount of laking must not be used. If careful technique has been employed, the red cell suspension will often be free from laking for three or four days.

It is important to select the proper individual from whom the blood is to be obtained. Tuberculosis and syphilis must be excluded, the patient must not only be free from any evidence of disease, but must not have been recently ill, nor have received any injury, must not have had even the slightest operation, and must not have received an anæsthetic. The blood of individuals who have had any of these conditions is unfit for injection purposes. The blood can, however, be taken from a patient during the early stage of ether anæsthesia. Elsberg, Neuhof, and Geist have found that the most satisfactory blood is that obtained from small children, and in the hospital they have usually obtained it from little patients who were to be operated on for hernia.

The authors have given injections of the blood of animals whose cells are known to be resistant to hæmolysis by normal human serum, but the results obtained were not satisfactory. They have also made injections of mixed cells from several individuals, but soon found that there was no advantage to be gained from blood mixtures. Finally they used suspensions of various strengths for injection purposes, but have found that the 20 per cent suspension yield the best results.

The method of injection: A hypodermic syringe which has been boiled in normal saline solution and cooled is filled with the blood mixture. The reaction begins to show itself in about five hours after the injection; it gradually increases in intensity until it has reached its height in six to eight hours. When fully developed the reaction appears as a somewhat irregular oval area with a well defined margin measuring from 1 x 2 to 3 x 5 cm. The margin is often surrounded by a whitish areola. The color of the lesion varies from a brownish red to a maroon, with, rarely, a bluish tinge. The lesion is distinctly raised from the surrounding skin surface. The raised area has a slightly bogged feeling, as if there were a subcutaneous exudation, and it is often somewhat tender. When the lesion has disappeared there remains behind a flat yellowish or greenish discoloration such as is left by any small ecchymosis. In those cases in which the characteristic lesion does not appear the skin either presents no change except the needle puncture, or a small flat area of varying color; rarely, the skin is raised, but of normal color.

Up to the present time the authors have given 684 injections to 432 patients.

A positive skin reaction was observed in 90 per cent of the patients with carcinoma (excepting the very advanced), and there was no reaction in 94 per cent of the patients who were suffering from other diseases. Of the patients in whom carcinoma was suspected but could not be proved 78 per cent gave a positive reaction. In all of the patients with advanced malignant disease, with metastatic deposits in the various viscera or miliary carcinoma, etc., no skin reaction was observed after the injections.

In a preliminary series of 100 cases (over 1,500 individual tests) Ottenberg and Epstein attempted to settle for themselves various questions of technique. They believe that the method which they have finally adopted gives results strictly comparable with those of the usual method. The chief advantage of this modified technique is that it enables one to perform a large number of tests readily with a small amount of blood. They examined 100 persons. These were taken in groups of 10 to 15, the serum of each one of the groups being tried in turn on the washed red blood cells of every other member of the group. The usual controls of each variety of red cells with its own serum with salt solution were made.

Of the 100 subjects, 38 were suffering from malignant tumors, 40 had other diseases, and 22 were apparently healthy. The diagnosis in nearly all of the tumor cases was confirmed by operation and microscopic report. The diagnosis in the other cases rested generally on clinical data. In the 38 cases of malignant tumor, 28 patients had serum which was hæmolytic — a proportion of 76 per cent. In the 40 other diseases, 20 patients had hæmolytic sera (50 per cent). Of these 6 were cases of tuberculosis — a well recognized

cause of isohæmolysis; 5 of the six sera were hæmolytic. If we exclude the tuberculous cases, 15 cases, that is 42 per cent, of the 35 remaining cases of disease were hæmolytic.

Of the 22 normal persons, 1 showed hæmolysis (5 per cent). This was a patient who had been operated on for hernia several weeks before and in whom no signs or symptoms of any disease could be elicited. Nineteen of the 27 sera which gave strong hæmolysis were from cases of cancer (74 per cent). That is, 50 per cent of the 38 cases of cancer gave strong hæmolysis. Seven cases (17 per cent) of the 40 other diseases examined also gave very pronounced hæmolysis and the 1 hæmolytic case in the group of normals also showed a very strong hæmolysis. These actively lytic cases were as follows: Chronic gastritis (?); chronic thyroiditis (tuberculous); normal (hernia); diffuse lipoma; colloid goiter; lead-poisoning; tuberculosis; fibroadenoma of breast. As a result of this work, the chief object of which has been to determine the value of isohæmolytic reactions in diagnosis, Ottenberg and Epstein are forced to the unsatisfactory conclusion that the method is not at present to be relied on for diagnosis. While it is true that in a majority of cases of malignant tumor this property of the blood is shown, it is also shown in a considerable proportion of other diseases The most that can be said is that in a given case, if tuberculosis can be excluded, a strongly hæmolytic serum is rather suspicious of carcinoma

The basis of the skin reaction for carcinoma is the subcutaneous injection into the forearm of about five minims of a 20 per cent suspension in physiologic salt solution of red blood cells obtained from a normal, healthy individual. If the patient's serum is hæmolytic for normal cells, an oval area of discoloration about 2 x 5 cm. will appear at the site of injection in from 5 to 8 hours.

The discoloration is described as "brownish red to a maroon, with rarely a bluish tinge The lesion is distinctly raised from the surrounding surface." The discoloration persists from one to three hours, and usually begins to fade at the end of eight hours, leaving a greenish ecchymosis at about the end of 12 hours. The element of time here is variable, however. If the patient is in a hospital, he should be observed about once an hour, beginning about 5 hours after the injection and making three or four observations. If the patient be at home, he may be conveniently seen about 6 hours after the injection. If the observation then made be inconclusive, he may be instructed to notify the physician should a reaction appear within three or four hours.

The blood required should, of course, be obtained under aseptic precautions, and from an individual who is not ill, has not lately been ill, free from syphilis or tuberculosis, and who has not recently had an anæsthetic. These factors seem to interfere with the reaction. The quantity of blood necessary varies of course, with the number of reactions to be carried out. For ten or a dozen reactions 2–3 cc. are obtained as described previously. Sufficient blood for two or three tests may be obtained by simply puncturing the finger and allowing a dozen drops to flow into a centri fuge tube half full of salt citrate solution. This is immediately centrifuged, washed three times as previously described, and made into a 20 per cent suspension in physiologic salt solution. The suspension is placed at 0° C. for 24 to 48 hours and is then ready for use. A convenient method of keeping this suspension until ready for use is to draw up a sufficient quantity for individual test into pipettes and seal the ends The suspension does not keep longer than 5 days and one should see that no hæmolysis has occurred previous to using it for injection.

Krida has made 76 tests. Of 12 cases of carcinoma, the reaction was positive in nine, or 75 per cent. In four cases of carcinoma without clinical recurrence, the reaction was uniformly negative. In 23 cases of a variety of diseases, 1, or 4 per cent (chronic ulcers), presented a positive reaction. Of 25 clinically well persons, 2, or 8 per cent responded positively to the reaction. In a certain small number of cases not clinically carcinomatous, a positive reaction was obtained. There were in all five such cases, on all of which Krida applied a second test two or three days after the first. The second test was positive in three of the cases: one of these was a case of chronic ulcers; two were normals. The remaining two cases, clinically well, proved negative Krida concludes that the hæmolytic reaction occurs in so great a percentage of carcinoma cases and in so small a percentage of normal individuals and patients with other diseases, which conditions can usually be differentiated, as to make it of material diagnostic assistance in doubtful cases, especially in carcinoma of the gastro-intestinal tract. Especially as it is so simple of application, it should be performed in all suspected carcinoma cases. The "in vivo" or "skin reaction," because of its better scientific basis, and because it is technically less difficult and time-consuming, Krida regards the clinical method of choice.

Weil's work showed that in a series of 82 cases, 56 per cent of sera from patients affected with advanced malignant growths was hæmolytic to normal alien corpuscles. Of the cases of benign tumors examined, 33 per cent was productive of a like hæmolysis, and in 26 per cent of sera from patients ill, but clinically non-cancerous, similar results were observed. No apparrently normal sera produced destruction of alien cells.

The investigations of Whittemore showed that of 109 cases treated, clinically well and otherwise, "direct hæmolysis" occurred in 36 per cent of the carcinoma cases, in 50 per cent of the tuberculous patients —all stages of the disease — in 18 per cent of patients suffering with ailments other than cancer and tuberculosis, and in 17 per cent of clinically well individuals Blumgarten reports that in his series 72 per cent. of sera from cancer patients produced direct hæmolysis, while the sera from but 10 per cent of patients affected with other than malignant disease were hæmolytic.

The results obtained by Crile and his assistants have thus far been the most encouraging. These investigators report a series of 541 cases. Of this series 211 individuals were clinically well. In none of these subjects was the hæmolytic reaction described by Weil

obtained. In about 10 per cent of 71 cases of pyogenic infection there was hæmolysis of alien corpuscles. Of 55 cases of benign tumors, no sera were reported as hæmolytic. Of 153 cases of malignant disease — all stages — the sera from 130, or 85 per cent, produced varying degrees of hæmolysis of healthy human red cells. Of 11 cases of cancer with clinical recurrence, 100 per cent maintained persistence of the positive reaction. Of 37 cases, post-operative, without clinical recurrence, examined at periods of from three weeks to 15 years after operation, none exhibited hæmolytic power of their sera toward healthy alien cells. Of 52 cases of tuberculosis, 92 per cent showed the reaction which Crile has called "reverse hæmolysis," i. e., the destruction of erythrocytes from the tuberculous patients by sera from healthy aliens. Crile and his co-workers noted that the cancer cases showing no hæmolysis were late inoperable growths; that cancers of the mucous surfaces showed more uniform hæmolysis than did those located in deeper tissues; that in cases which had been operated on with clinically no recurrence, the hæmolytic power of the sera was lost in from 12 days to 3 weeks; that in cases where the incomplete operation had been performed the serum never lost its hæmolytic power; that chilling the sera appeared to increase hæmolytic power, while heating it above 55 degrees Centrigrade seemed to destroy the hæmolytic property.

In a more recent communication, Johnstone and Canning report results similar to those described by Crile. In the main, they claim to have used the technique described by Crile and his assistants. Three hundred and one cases are tabulated. In the cases of carcinoma (42 in number) the hæmolysis (direct) was positive in 85.7 per cent. In 9 cases of sarcoma, the direct hæmolysis was determined in all cases.

Two cases of endothelioma were positive. Of 14 benign tumors, the serum reaction was negative uniformly. Of 43 cases of tuberculosis, 16 per cent showed reversed hæmolysis, the remaining cases were negative. Johnstone and Canning also report positive reactions in septic infections, typhoid fever, lobar pneumonia, normal individuals (error in technique) and with Coley's fluid.

Smithies' first report was based on the findings from the investigation of the sera from 85 individuals. Of these there were 12 cancer cases. Seven, or 58.3 per cent, showed positive reaction. There were two benign tumors. In neither was there a positive reaction. Of 15 cases of tuberculosis, two showed reverse hæmolysis, and one showed the typical "cancer reaction" (direct hæmolysis). There were 12 cases of syphilis The positive reaction was obtained once in these.

There were 35 cases of diseases other than those quoted; 5 showed hæmolysis similar to that exhibited by the cancer patients and one showed "reverse hæmolysis." Of 19 normals, one showed the direct hæmolysis as manifested in the cancer cases.

Smithies has continued his investigations and the final results to date furnish the basis of his last communication. They comprise observations on 158 persons affected with various ailments and clinically well. Apart from the cancer cases, particular interest was attached to the findings in the cases of tuberculosis, syphilis, the anæmias. and those diseases with anæmia. The work summarizes the reactions in 31 malignant tumors. Fourteen of these (45.1 per cent) gave positive reaction. Four showed reverse hæmolysis, three were undetermined, and 10 were negative. The cases in which positive manifestation was noted were in general late and moderately advanced lesions. This is not the rule, however. The processes associated with necrosis seemed to cause more prompt and more distinct hæmolysis, in the main, than those where the tumor masses were well preserved. Portions of the body where the circulation is perhaps less marked — as bone and prostate gland — appeared to respond slowly, even though the cancerous process was well advanced. Cancers of the uterus were accompanied in general by distinct and prompt hæmolysis. The cases of cancer where anæmia was more pronounced appeared to give more definite positive reaction than those where the lesion was well confined, with slight anæmia. This also applies to cases where the loss of weight had been marked and rapid. Of three benign tumors examined none gave positive reaction. In none was the anæmia or the loss of weight prominent. The consideration of the tuberculous case is interesting.

Forty-five cases are tabulated. But two of these gave a positive reaction. In none was the anæmia or the loss of weight prominent. The consideration of the tuberculous cases is interesting. But two of the forty-five cases tabulated gave a positive reaction, and only 5 showed "reverse hæmolysis." All the cases showing "reverse hæmolysis" were moderately advanced cases of pulmonary tuberculosis, and were all anæmic, febrile, and had lost weight. Eleven cases are classed as undetermined. Twenty-seven cases showed no reaction either way. To these belonged no particular type of the disease. It is interesting to note, however, that 11 were cases of incipient tuberculosis without anæmia and little fever and loss of weight, and 5 were well localized lesions confined to the pleura and lungs with fair general state. Some of the other cases with anæmia — as for example, tuberculosis of the bowels and bones — showed distinct hæmolysis both ways.

There were 19 syphilitics examined. Four, or 21 per cent, gave positive reaction, while an equal number were undetermined. Eleven were negative. There were no cases of "reverse hæmolysis." All the cases of syphilis showing positive reaction were cases of tertiary with more or less severe anæmia. The cases of visceral syphilis seemed to respond more noticeably than others.

The study of 36 cases other than cancer, tuberculosis, and syphilis is most interesting, and is perhaps the most important feature of the communication. Five of these cases, 13.9 per cent (namely, two cases of chlorosis, one case of arteriosclerosis with secondary anæmia, and two secondary anæmias from infectious disease) showed moderately well marked positive reaction. Twenty cases are negative. Two cases showed reverse hæmolysis. These were one case of

achylia gastrica with trichomoniasis and anæmia, and one case of the chronic interstitial nephritis. In the former case the reaction was not well marked but distinct enough to be called a hæmolysis. Eleven cases are classed as undetermined. A rather striking proportion is found in those disease conditions associated with anæmia.

Of the 24 normal individuals (clinically well) but one case showed positive reaction. One might question whether or not there was some slip in the technique in this case, but as far as known there was no error, and the evidence must be accepted for what it is worth, inasmuch as the patient appeared very well at the time his blood was taken. Some old tuberculous focus or some recent infectious disease may have modified the test in a way not understood at present.

Certain facts are brought forward prominently. It seems that in the blood serum of some cases of malignant disease — those generally associated with anæmia and loss of weight — there exists a hæmolytic property for alien red cells. It also appears that while this phase is interesting and may be of value in certain individual cases, similar manifestations are possible from the sera of patients non-cancerous. It will be noted, however, that the conditions where this direct hæmolysis is obtained are those frequently associated with anæmia, loss of weight, and cachexia. The reaction of reverse hæmolysis mentioned by Crile as occurring in 92 per cent of cases of tuberculosis is characteristic. It occurs occasionally but is by no means characteristic, inasmuch as it also occurs in malignant disease, syphilis, and other disease. As Crile suggests, this work also shows that the transfusion of blood from one individual to another in cases of emergency is a dangerous procedure unless previously determined that the individual is free from malignant disease, syphilis and other diseases.

In conclusion Smithies emphasizes that while the main mass of data is at present against the hæmolytic reactions being characteristic for any single class of disease, yet the larger number of cancer cases showing this reaction should urge us to seek modifications of the method in the hope that study of various sera along other lines will lead to the firm establishment of a specific reaction for cancer and other disease conditions which seem to have specific pathology.

Appendicostomy in the Treatment of Chronic Constipation. P. L. MUMMERY. *Practitioner*, 1910, vol. 84, p. 700.

According to Mummery there are three classes of cases for which this operation is suitable:

1. Cases of severe atonic constipation in which the whole colon is much dilated and sacculated.

2. Those cases of obstructive constipation in which it is not possible to deal directly with the obstruction.

3. Cases of congenital dilatation of the colon.

The operation is a very simple one and if properly performed causes no inconvenience on the part of the patient, not even a pad being necessary. For closing the opening cauterization with a silver nitrate stick is sufficient.

The operative technique is as follows: Appendical incision. The appendix is drawn through the wound until the cæcum is against the abdominal wall, when sutures are passed through the wound and colon anchoring the colon to the abdominal wall. A pad is then placed over the appendix and the tip end of the appendix opened and a small catheter passed through to determine if it is patent. After the wound is healed the appendix is removed without an anæsthetic. For irrigation warm water only should be used, as antiseptics may prove poisonous. C. G. GRULEE.

The Changes Produced in the Kidneys by Experimental Ligation of the Ureter. G. D. SCOTT. *Bulletin of the Northwestern University Medical School*, vol. xii, No. 1.

The author presents a preliminary report of his work in experimental ligation of the ureters with his conclusions as follows.

Twelve dogs in which the ureter had been tied have come to autopsy, and all show the same changes as those here described. Without an exception, the twelve experiments support the following:

1. Contrary to the accepted theory, a sudden, complete, permanent obstruction of the ureter produces a hydronephrosis of a high degree.

2. Hydronephrosis develops with greater rapidity after a sudden, complete, permanent obstruction of the ureter. ARTHUR B. EUSTACE.

Symmetrical Perivascular Lipomata (Lipomes symétriques périvasculaires). L. DELREZ. *Archives générales de Chirurgie*, March 25, 1910.

The author in discussing these lipomata, says that their essential characteristic is the symmetry of the tumors. Though the condition is more frequent in men, women are not exempt. At the onset, the evolution is rapid but later is becomes stationary and the tumors may persist for 25 to 40 years or even to the end of life, without causing much disturbance. At times these tumors generalize. For instance, they invade the mediastinum and cause death from asphyxia. The usual seat of the tumor is the neck. The upper extremities may be involved. In the neck, the submaxillary, the carotid, the nuchal, and the mastoid regions are frequent seats. When the superior extremities are involved the lipomata constantly have the following distribution in the bicipital groove, and in the axillary space. In the inferior extremities, the groin and the antero-internal surface of the leg and thigh are the usual seats. These tumors are thought by some to depend upon nervous disturbances. The nervous theory is unsatisfactory because it does not explain the total absence of other trophic disturbances nor the existence of odd tumors occurring in the median line either behind and below the manubrium or along the course of a large vessel.

The denomination of symmetrical perivascular lipomata is based upon the embryological facts and upon anatomical findings and is justifiable if not in all at least in the large number of cases.

AIMÉ PAUL HEINECK.

ABSTRACTS OF CURRENT LITERATURE

DEPARTMENT OF GYNECOLOGY

UNDER THE CHARGE OF

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The Utilization of the Vagina as a Drainage Channel after Total Hysterectomy (De l'utilisation du conduit vaginal en guise de drain après l' hystérectomie totale). M. CHAPUT. *Revue de Gynécologie et de Chirurgie Abdominale*, January, 1910.

To utilize the vagina as a drainage channel (no tube or gauze drainage being employed) one first performs a total abdominal hysterectomy and leaves unclosed the vaginal opening into the small pelvis, utilizing this canal as a drain.

It can be employed in three different instances: 1. To drain the peritoneal cavity after a diffuse peritonitis. 2. To drain the small pelvis after total hysterectomy and partition of the pelvis. 3. As a drainage channel after total vaginal hysterectomy.

After operations upon the uterus and adnexæ, the partition of the pelvis will be established. To effect this the vesico-uterine peritoneum is sutured to the sigmoid loop and to the superior strait. Beneath this the vagina gaps and assures drainage without the aid of gauze or tube. All dry cleanings or injections of the vagina are to be avoided as these maneuvers irritate the pelvic peritoneum. The pelvic toilet at the time of micturition and defecation will be made with dry gauze. The evacuation of the bladder is assured by intermittent catheterism or by the placing of a permanent catheter.

To be considered with these inconveniences of tubal vaginal drainage, the following are the advantages of vaginal drainage without the aid of tube or gauze.

1. The vagina is a channel having a larger diameter than that of any drainage tube which it will admit.

2. Unlike drainage tubes it can neither be kinked or clogged.

3. Its mode of action is unlike that of tubes. Tubes favor as much the reflux of liquids into the pelvis as their outward egress. The vagina gapes above and is virtually closed below and functionates in about the same manner asothe ileocæcal valve. It evacuates secretions and opposes the ascent of air and external contaminations.

4. The vagina cannot be obliterated or clogged the the same as tubes, and for several reasons; its caliber is larger, its surface is smooth, the mucus which covers it favors the gliding and evacuation of coagula.

5. The vagina does not extend as high into the pelvis as does a drainage tube, the height of the recto-vaginal cul-de-sac is therefore not increased. It can even be suppressed by a V-shaped excision of the posterior vaginal wall.

6. Vaginal drainage without tubes has the disadvantage of foreign bodies which irritate and may exert traction on the organs.

The author has employed vaginal drainage without tube and with partition of the pelvis after vaginal hysterectomy in 25 cases; 20 cases of salpingitis and 5 cases of fibromata. All cases recovered.

It is indicated in all cases of total abdominal hysterectomy (fibromata, salpingitis, uterine cancer). In these cases it can be combined with partition of the pelvis. It is also indicated in cases of generalized peritonitis except in these cases one dispenses with partition of the pelvis; it is indicated in vaginal hysterectomy. AIMÉ PAUL HEINECK.

Complementary Colopexy in Operations for Utero-Vaginal Prolapse (Colopexie complémentaire des opérations pour prolapse utéro-vaginal). MAUCLAIRE. *Archives générales de Chirurgie*, March 25, 1910.

Utero-vaginal prolapse is being more and more considered as a true hernia of the pelvic floor. There is a weakening of the pelvic floor, the uterus, bladder and rectum sag increasingly and what, in my mind, is of great importance, the large intestine with its weighty contents, descends gradually into the pelvic infundibulum and contributes very much to the maintenance of the genital hernia. The ptosis of the large intestine augments the utero-vaginal ptosis. There exists in the pelvis peritoneal depressions prepared to receive the intestine, the pelvic colon usually, the small intestine, rarely. The ptosis of the small intestine is less harmful as it is lighter and less voluminous than the large intestine and in strains it is the large intestine that exerts the greater pressure upon the pelvic floor.

That is why in two cases of marked prolapse the author supplemented the usual operation employed in such cases by a colopexy of the cæcum and of the pelvic colon. In the last case, a patient 60 years old entered my service for a complete uterine prolapse with irreducible rectocele and cystocele. The uterus is descended below the vulva, anterior and posterior colpocele. There was pain upon standing and especially

upon walking, the uterus was hypertrophied and the cervix very large. Patient was unable to do any work.

The author performed the following operation: Vaginal hysterectomy, closure of the peritoneal orifice without drainage, posterior colpoperineorrhaphy, laparotomy incision in the left iliac fossa and fixation of the pelvic colon for a distance of 10 centimeters in the ileo-abdominal angle.

Recovery. Patient works, has no pain when she moves; in violent paroxysms of coughing there is slight prolapse of the anterior vaginal wall.

I believe the good result in this case is due to the colopexy and not to the vaginal hysterectomy and colpoperineorrhaphy which is as we know almost always inadequate in utero-vaginal prolapse of the third degree. The colon may be fixed to the anterior abdominal wall or to the iliac fossa as Quénu and Duval have recommended and practiced in cases of exaggerated rectal prolapse. In their technique the supporting sutures pass successively through the psoas magnus, the tendon of the psoas parvus, and the margins of the incised parietal peritoneum. AIMÉ PAUL HEINECK.

Hot and Cold Irrigation in Gynecology (Le irrigazioni vaginali calde e fredde nella pratica ginecologia). Editorial review by DR. REBAUDI. *La Ginecologia Moderna*, September, 1909.

1. Cold vaginal irrigations, the temperature of the water being 70° F. gradually cooled to 60° F. These are efficacious in metrorrhagia.

2. Hot vaginal irrigations, using 40 to 50 quarts of hot water per treatment followed by hot perigastric irrigations.

3. In cases of pelvic cellulitis, ovaritis, or salpingitis, better results are obtained when the irrigation is affected through the rectum. The temperature of the solution should be from 122–130° F. This solution is allowed to flow into the rectum very slowly and patient is requested to retain same for half an hour.

The following advantages are claimed for this method:

1. Increased local blood supply.

2. Removal of inflammatory tissues (via the hyperactive lymphatics).

3. Contraction of muscle fibers tending to loosen adhesions. GEORGE DE TARNOWSKY.

A Case of Gangrene of the Leg Following Abdominal Hysterectomy (Un Caso de Gangrena de la Extremidad Inferior Despues de una Histerectomia Abdominal). DR. GUILLERMO RIBAS. *Revista de Medicina Cirujia, Barcelona*, December, 1909.

A woman of 26, otherwise in good general condition, was suffering with double pyosalpinx, which continued to grow worse with palliative treatment, so that an operation was finally made in spite of a temperature running about 39° C. The conditions were found to be such as to necessitate removal of the uterus and adnexa. Three days later the patient began to have severe pains in the toes of the left foot, followed by a slowly developing progressive dry gangrene, making amputation necessary five weeks later An acute nephritis developed and the patient died with uræmic symptoms ten days after the amputation. The cause of the gangrene was found to be an infective endarteritis.

B. J. O'NEILL.

Experimental Researches Concerning Drainage (Experimentelle Untersuchungen über Drainage). BOXER AND NOVAK. *Wien. klin. Wchnschr.*, 1910, xxiii, 247.

The experiments carried on were in test tubes and on dogs. After a rather thorough experimentation they came to the following conclusions:

1. Of the material useful for capillary drainage the cotton yarn wick seems best characterized. By impregnation with iodoform it loses some of its absorptive ability but even then is better than almost any other materials.

2. For active drainage it is necessary that the wick be in direct contact with a sterile bandage material which absorbs well and should always be dry.

3. For prevention of cutting off the drainage the wick should be surrounded by a protective covering for which the glass drain is best employed.

4. By prevention of all stagnation of secretion especially by frequent change of the sterile bandage material one can prevent a secondary infection of the drained wound cavity.

5. Of the material used for tubular drainage glass seems to exert the slightest irritative action.

C. G. GRULEE.

Fig. 1

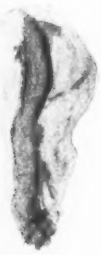

Fig. 2

Fig. 3

Fig. 4

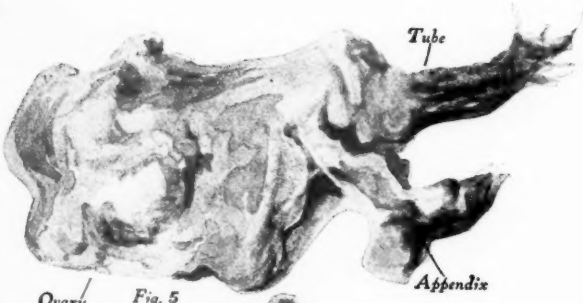

Fig. 5

Right Ovary

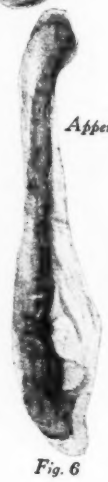

Fig. 6

Left Ovary